

Friden

MODEL 1217 PRINTING CALCULATOR OPERATIONS

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MAIN CLUTCH ENGAGING - Sketch 1

Depression of any operating key shown in Sketch 1 will cause the low speed microswitch to close, starting the motor; and rock the clutch dog latch out to allow the clutch dog to engage the ratchet in the main clutch to turn the main drive shaft. Note that the "To Memory" and "From Memory" keys are not operating keys but must be used in conjunction with one of the operating keys.

Depression of any operating key will cause the right clutch throwout slide (Sketch 1) to move forward, either directly as the "Repeat Add" and "Non Add" keys or indirectly through the clutch throwout shaft. Forward movement of the right clutch throwout slide moves stud A forward, this rocks the keylatch live-point forward. When stud A is clear of the front of the keylatch lever, Spring Y causes the keylatch lever to rock counterclockwise and the switch control link to move forward. This rocks the microswitch bellcrank clockwise to close the microswitch and start the motor. Forward movement of the switch control link also pulls the clutch dog latch out of engagement with the main clutch allowing the clutch dog to engage the ratchet and rotate the main drive shaft.

MOTOR and GOVERNOR - Sketch 2

The printing calculator is driven by a two speed motor. The motor operates at 150 machine cycles (main drive shaft revolutions) per minute for most operations and at 235 cycles per minute maximum during the counting operations in multiplication and division. High speed operation of the machine is explained in the MULTIPLICATION and DIVISION sections. The motor drives the main clutch ratchet gear through the worm reduction gear shown in Sketch 1.

Sketch 2A shows the actual wiring of the motor and switches.

A governor is provided to maintain the motor at the proper speed for correct machine operation. Since there are two motor speeds in the printing calculator it is necessary to have a two speed governor. The governor consists of two pairs of contacts. Each pair includes one fixed contact and one mounted on a leaf spring. As the speed increases centrifugal force causes the spring mounted contact to swing away from the fixed contact. As can be seen in the schematic for the low speed governor contacts in Sketch 2B when the governor contacts open the resistor is placed in series with the motor and limits the voltage to it, thereby reducing the speed. As the motor speed is reduced the spring mounted contact again closes, shorting out the resistor and in effect

eliminating it from the circuit so that the full line voltage is again applied to the motor and its speed begins increasing until it again reaches the point where the governor opens and the process repeats itself.

The operation of the high speed governor contacts, as shown in the schematic in Sketch 2C, is similar to the low speed contacts described above except that the spring on the moveable contact is much stiffer so it does not open until a higher speed is reached. When the high speed microswitch is open as in Sketch 2B the high speed governor is eliminated from the circuit. When the high speed microswitch is closed as in Sketch 2C both sets are in the circuit however the high speed contacts maintain the full voltage across the motor until the higher governed speed is reached.

The purpose of the capacitor in this circuit is to reduce voltage surges when the contacts are opened and closed, prolonging the life of the contacts.

SINGLE CYCLE MECHANISM - Sketch 3

The single cycle mechanism limits the main clutch to one cycle even if an operating key is held depressed at the end of the cycle. During repeat add, equals, and division operations the single cycle mechanism is disabled.

As the roller on the switch link restore cam passes the high point A the clutch restore cam follower is rocked toward the rear of the machine. This pulls the restore lever up to engage stud R and rock the clutch dog latch into engage the clutch dog and rock it out of engagement with the ratchet. This clockwise movement of the clutch dog latch raises the key latch lever and the key latch live-tip above stud P to allow the clutch throwout slide to restore and release the depressed key. If the key is held depressed the clutch throwout slide cannot move rearward and the key latch live-tip will rest on stud P until the key is released and stud P can move rearward under the key latch lever. Clockwise movement of the clutch dog latch also allows the switch control link to move rearward, rocking the microswitch bellcrank up and opening the microswitch to stop the motor.

The single cycle mechanism is disabled by lifting the restore lever up so the hook cannot engage stud R and rock the clutch dog latch into the clutch. When the repeat add key is depressed stud N rocks the single cycle disabling link down. The spring pulls the single cycle disabling lever counterclockwise, and stud D lifts the restore lever up so the hook will pass above stud R when the clutch restore cam follower is rocked back.

The single cycle disabling shaft is rotated clockwise by the depression of the division key and the equals keys as described in those sections of this manual. The rotation of this shaft rocks the single cycle disabling link downpulling the spring to rock the single cycle disabling lever to raise the restore lever above stud R.

DRIVE SHAFTS - Sketch 4

The timing of all operations of the printing calculator is controlled by the drive shafts shown in Sketch 4. The main drive shaft is driven by the motor, through the main clutch. The rear drive shaft is driven by the main drive shaft through the three large gears on the left side of the machine. The division program shaft is driven by a small gear on the rear drive shaft through a four to one reduction. The functions of the various cams are explained in other sections of this manual. It is very important to learn the location

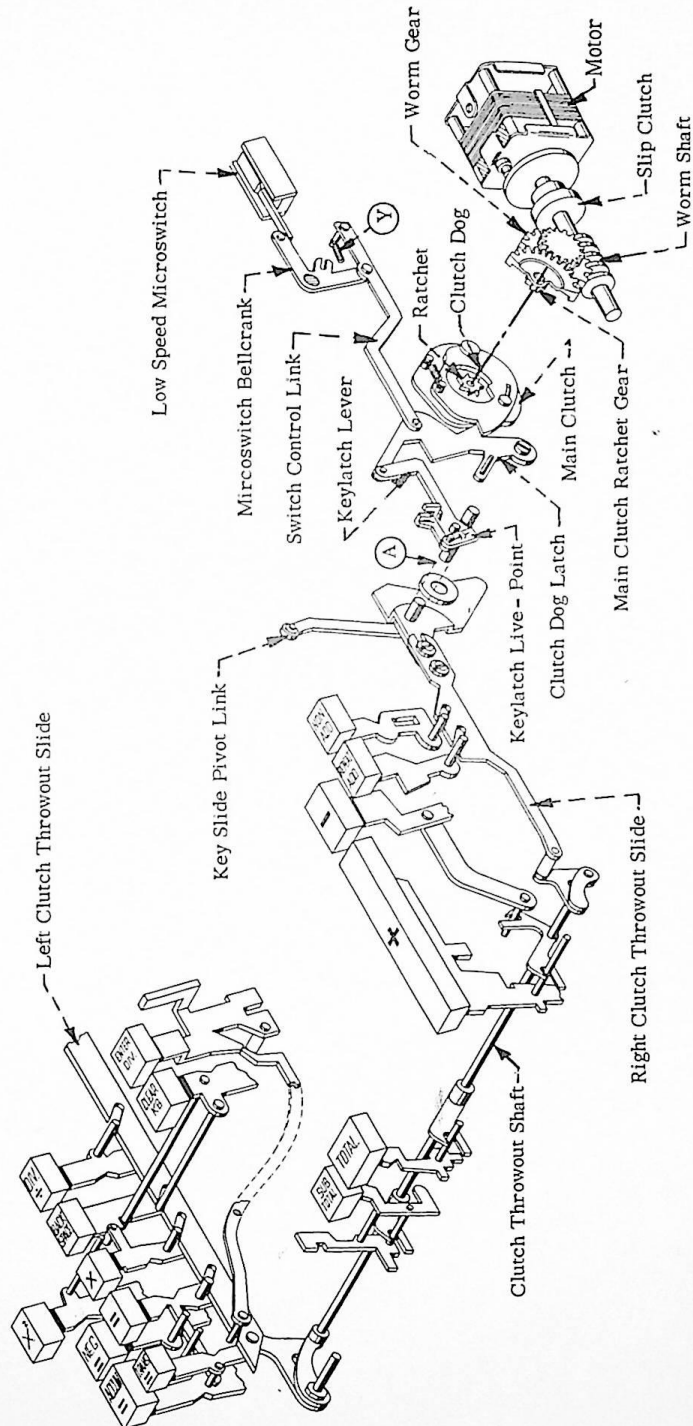
and function of all the cams since this is often the best place to begin tracing an operation.

The torque compensating cam at the left end of the main drive shaft acts in conjunction with a spring loaded follower to keep the drive shaft from speeding up or slowing down at those points in the cycle when heavy loads are placed on other cams.

The purpose of the overthrow block cam, at the right end of the rear drive shaft, is to prevent the rear drive shaft from going past its home position. As shown in Sketch 3 when the microswitch bellcrank is rocked down to start the motor the ear of the overthrow block is rocked up away from the overthrow block cam, allowing the rear drive shaft to rotate. Near the end of the cycle the microswitch bellcrank rocks up and the ear on the overthrow block is lowered into position to stop the overthrow block cam and the rear drive shaft in home position.

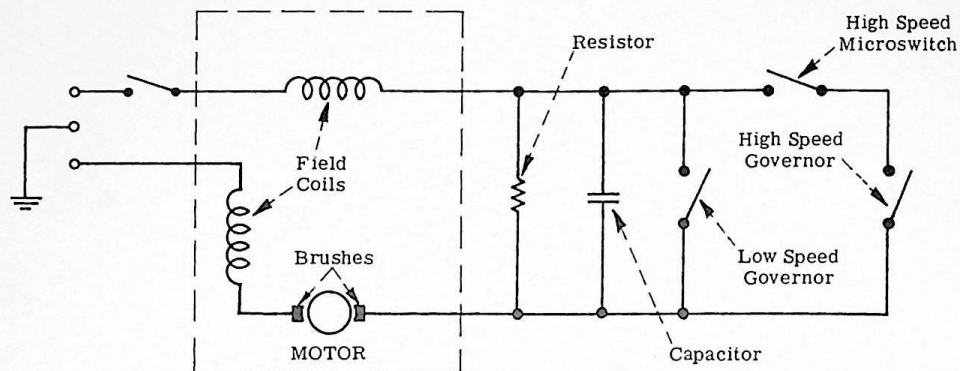
FRIDEN PRINTING CALCULATOR

OPERATIONS - Motor and Drive

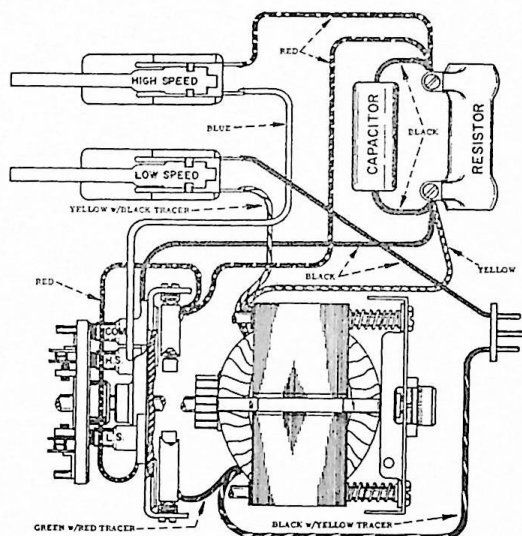


MOTOR & DRIVE

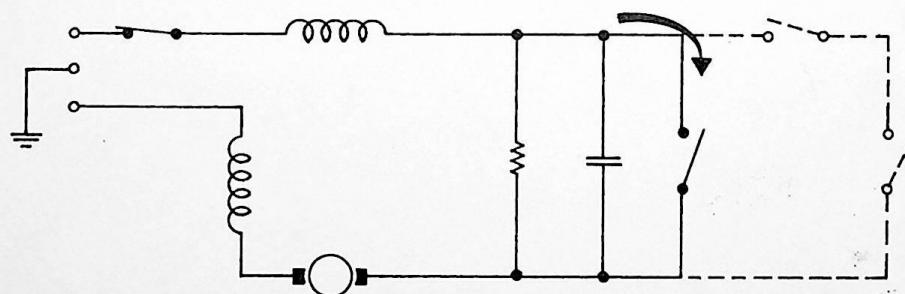
SKETCH 1



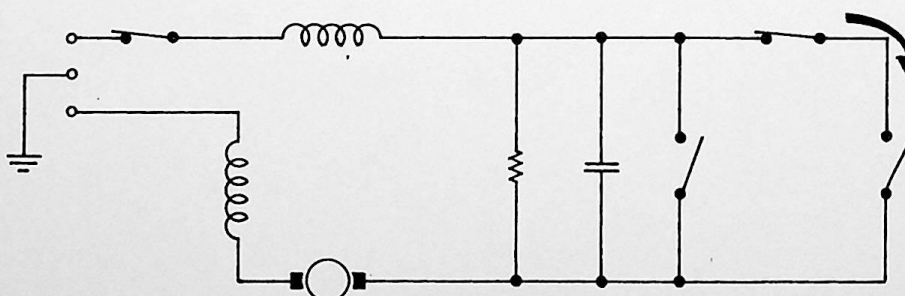
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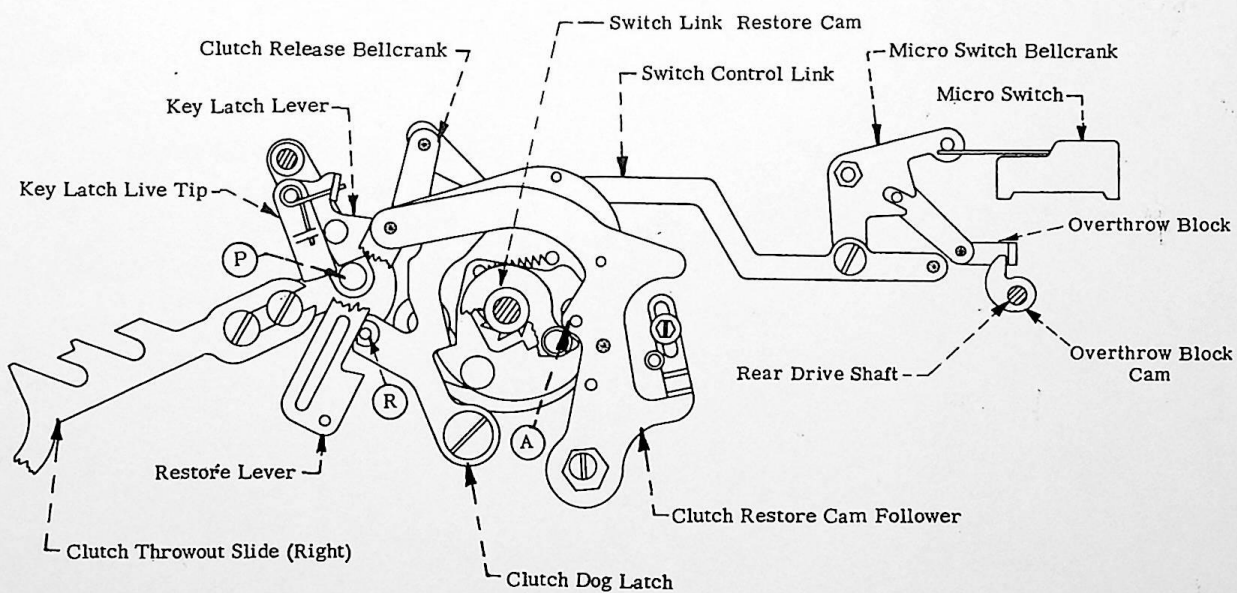
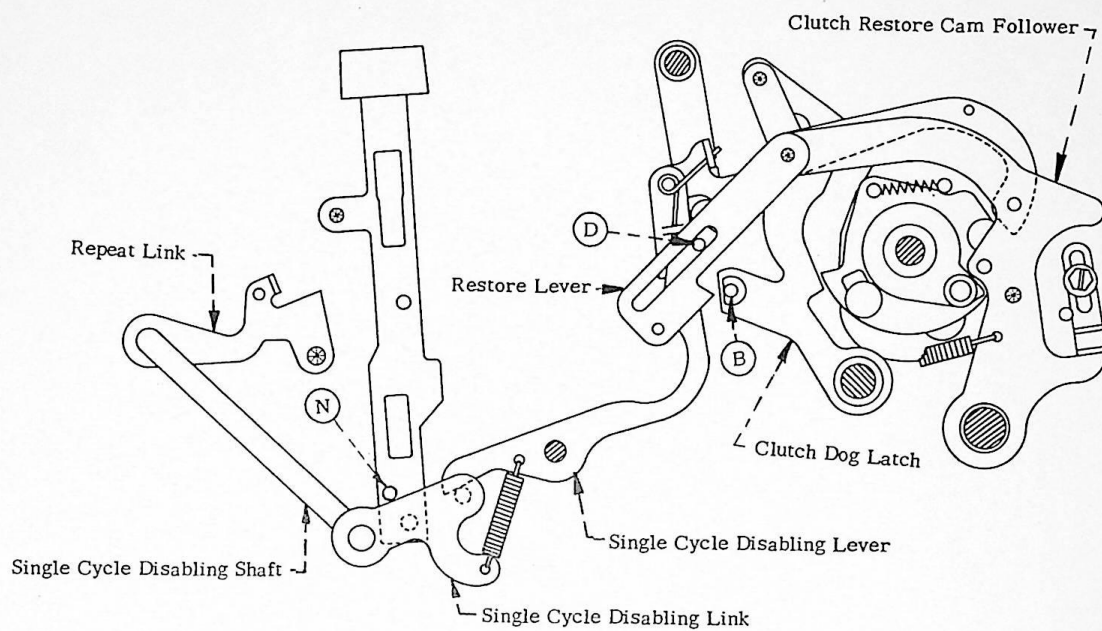


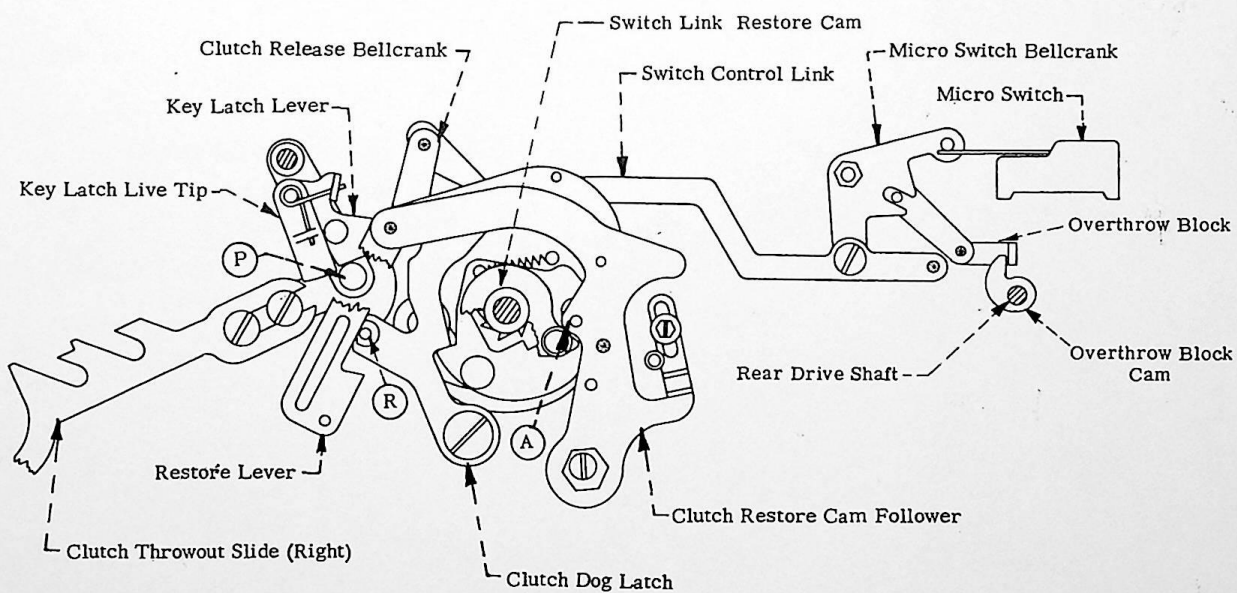
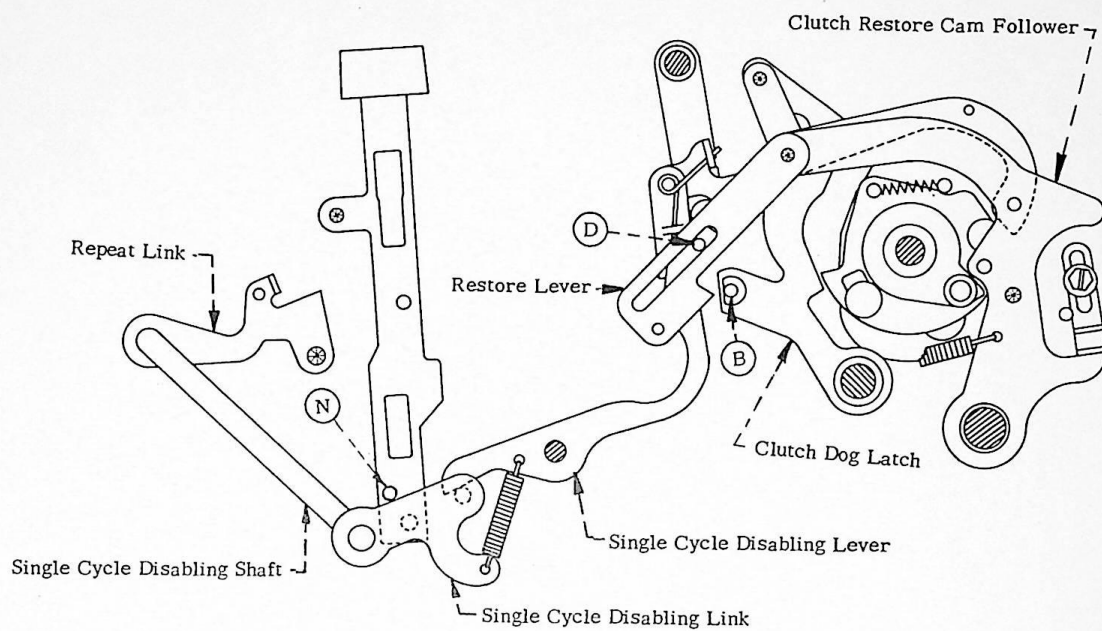
SKETCH 2B
LOW SPEED GOVERNOR
OPERATION

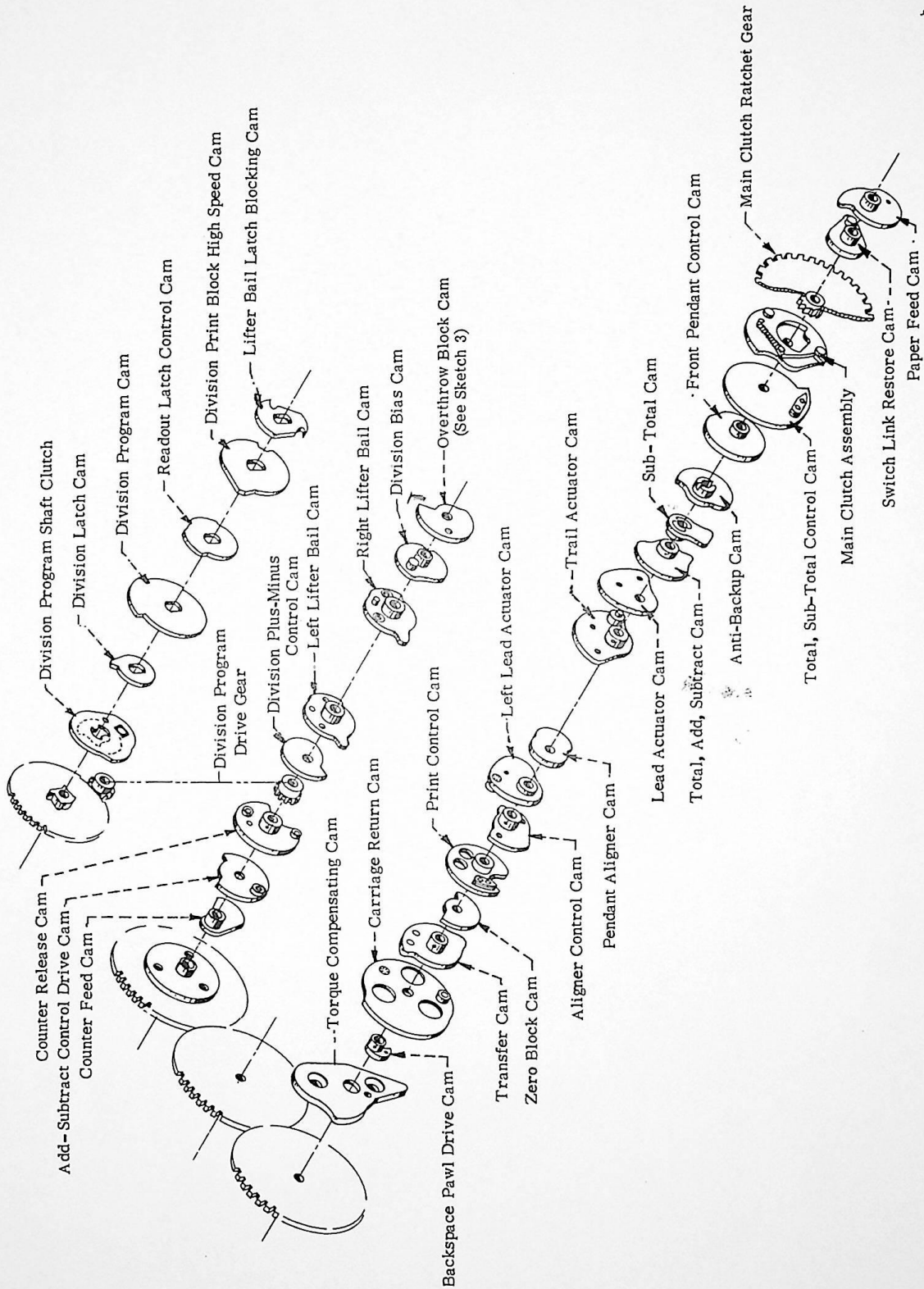


SKETCH 2C
HIGH SPEED GOVERNOR
OPERATION

MOTOR & DRIVESKETCH 2

MOTOR & DRIVESKETCH 3

MOTOR & DRIVESKETCH 3



MOTOR & DRIVE

SKETCH 4

SELECTION - Sketch 1

The selection mechanism of the printing calculator consists of a 10-key keyboard, a carriage containing a set of check dial sectors which can be shifted in respect to the keyboard, and a means for shifting the carriage.

Sketch 1 shows a section of the selection mechanism. There is a setting lever associated with each selection key except the 9 and the 0. There is a row of setting pins for each check dial. With the carriage in home position the left row of setting pins and the left check dial sector are over the setting levers. After a selection is made in any order, the escapement pawl allows the carriage to shift one order (space) to the left, bringing the next row of setting pins into alignment with the setting levers.

PIN SET

With the carriage in home position, the first sector and its setting pins are over the setting levers. Depression of any selection key, except the 0 or 9, will cause its selection lever to push a setting pin up into a position to stop the check dial at the number selected. If the #5 selection key is depressed, the #5 setting lever will set the #5 setting pin in that order. If the #6 selection key is depressed the #6 pin will be set, and so on. Leaf springs hold the setting pins in position.

There is no setting lever or pin for the #9 key, the check dial stops against the fixed sector stop.

The zero key does not release a sector, and, therefore, does not require a stop.

SECTOR RELEASE

Each sector is held at 0 position by its zero latch. With the carriage in home position the left zero latch is directly in front of the sector release lever. As a selection key is depressed it rocks the sector release rod and the sector release bell-crank down. This pulls the sector release link forward and the sector release lever counterclockwise to release the zero latch. The sector is actuated by the sector spring and will rotate until it contacts a setting pin or the fixed nine stop. In Sketch 1 the sector is shown stopped against the #1 setting pin. The sector moved from 0 to 1 and the tooth side of the sector also moved 1 tooth space. This is important to remember as later it will be explained how this determines the printed figure and the figure to be stored in the accumulator.

UNIT ESCAPEMENT

As a selection key is depressed it contacts the sector release rod and through the escapement pawl actuator, rocks the escapement rod and the holding pawl downward moving the lip of the holding pawl into a tooth space of the escapement comb. The lip of the holding pawl moves the escapement pawl out of a tooth of the escapement comb. The spring tension will move the carriage slightly to the left until it contacts the lip of the holding pawl. Releasing of the key will permit the escapement pawl spring to actuate the escapement and holding pawls upward. The escapement pawl cannot move back into the same tooth space it moved out of because the carriage moved slightly to the left (see inset) and the escapement pawl is blocked by the next tooth. As the lip of the holding pawl is moving out of the tooth space the carriage will move to the left. The escapement pawl will be actuated into the next tooth space by the escapement pawl spring, stopping the carriage movement. Each escapement of the carriage allows the next sector to the right to be positioned over the setting levers and the sector release link. Lip X of the holding pawl is designed to slow down the carriage shift long enough to allow the setting levers and the restore link to restore sufficiently so they will not contact the next row of setting pins or the next zero latch during the shift.

ZERO ESCAPEMENT

Depression of the zero key pivots the zero selection shaft assembly which, in turn, rocks the escapement pawl actuator and the holding pawl down to allow the carriage escapement.

POSITIVE ESCAPEMENT ARM

The depression of a selection key will cause the setting pin to set and the sector to release. The sector will contact the beveled underside of the escapement arm cam. The momentum of the sector rotating will raise the cam and permit the sector to revolve to its selected position. When the cam is raised the front portion of the positive escapement arm will be actuated down and push the escapement pawl below the escapement comb teeth causing the initial part of the carriage escapement action, or the carriage "hop". The positive escapement arm causes this escapement action rather than the full depression of the selection key. The full carriage escapement occurs on the restoring of the selection key as explained previously.

SECTOR CLEAR - Sketch 2

Early in the machine cycle the front pendant is

rocked into engagement with the check dial sectors to transfer the selection to the actuators. (This will be explained in the Actuator Section.)

The selection dials are rocked back to their home position by the downward stroke of the actuators, through the gears on the front pendant. However, to insure the complete restore of the selection dials, the check dial restore shaft is provided, as described below. The check dial restore shaft also clears the selection dials during a total or sub-total operation when the front pendant is not engaged with the selection sectors.

As the actuators are driven down, the check dial restore assembly is rocked counterclockwise (Sketch 2) by the left actuator drive cam. This, in turn, rotates the gear on the check dial shaft to rock the check dial restore shaft clockwise, against the selection dials. The selection dials will be rotated slightly past their home position so the live points can latch on the sector latches.

CLEAR KEYBOARD KEY - Sketch 3

The Clear Keyboard Key clears the selection dials but does not allow the selected amount to be printed on the tape or entered into the accumulator.

Depression of the clear keyboard causes stud A (Sketch 3) to cam the clutch throwout slide forward to rock the clutch throwout shaft assembly and close the switch and engage the main clutch to start the machine. Since no other keys are depressed the machine will automatically go into a non-add cycle. The front pendant engages the selection sectors and on the downward stroke of the actuators the sectors are restored to their home position by the action of the front pendant gears and the check dial sector restore shaft, previously described.

Depression of the Clear Keyboard Key also rocks the print block hook up to engage ear D of the left ribbon control arm. Since ear D cannot rock to the rear, stud R is blocked and the print control arm cannot rock down to allow printing to take place. The paper feed block arm is not rocked clear of the stud on the paper feed cam follower, so a paper feed cannot take place.

SELECTION CARRIAGE RESTORE - Sketch 4

The selection carriage is escaped one space to left each time a selection key or the zero is depressed. This movement is transmitted, through the gear train shown in Sketch 4, to the overcapacity gear sector, rocking it forward. This also

pushes the carriage restore drive link forward. The cam shaped slot in the carriage restore drive link is only to allow it to move forward without moving stud B; it does not enter into the operation.

After the amount in the selection dials has been transferred to the actuators and selection dials have been restored to their home position, the roller on the carriage return control arm drops to the low of the carriage return cam. This, in turn, rocks the carriage restore drive link down and puts the carriage return arm yield in a position to intercept stud T on the carriage return cam. Stud T may contact the carriage return arm yield at any time after 180° of drive shaft rotation depending upon how many orders the carriage was escaped. As stud T contacts the carriage return arm yield it pushes it and the carriage restore drive link toward the rear of the machine. This, in turn, rocks the overcapacity gear sector rearward rotating the carriage return clutch assembly and the carriage return clutch gear to drive the backspace rack and the selection carriage return rack rearward. Rearward movement of selection carriage return rack rotates the carriage return idler gear and the selection carriage idler pinion to drive the selection carriage rack and the selection carriage to the right. When the selection carriage has reached its home, extreme right, position, stud T cams past the carriage return arm yield, and the carriage return control arm is raised to the high of the cam, restoring the carriage drive link to its home position.

BACKSPACE KEY - Sketch 5

The backspace key provides a means for taking out the last figure entered into the selection unit, if desired, to make a correction. It also backspaces the selection carriage one order so the correct figure can be entered. The backspace mechanism is also operated automatically in division to shift the divisor, which will be explained later.

Depression of the backspace key also depresses the clear keyboard key (Sketch 5), through stud M, to initiate a clear keyboard operation, previously described. At the same time the stud on the lower end of the key rocks the repeat control lever down causing stud W to rock the backspace repeat bail up to block the sector latches and prevent all but rightmost sector from being latched in home position. Rocking of the repeat control lever rocks the backspace control lever clockwise. This lifts the backspace pawl into engagement with the backspace rack. As the main drive shaft begins to turn, stud F allows the backspace control lever lock to move under the backspace control lever to hold it in place. After the right-

most sector has been restored to its home position by the keyboard clear operation, the backspace cam contacts the backspace pawl and drives it to the rear. This moves the backspace rack to the rear and through the gear train shown in Sketch 4 shifts the carriage one space to the right. Near the end of the cycle stud F on the carriage return cam rocks the backspace control lever out of engagement with the backspace control lever allowing all the parts to return to their home positions.

ZERO SELECTION INTERLOCK - Sketch 6

The zero selection interlock blocks the operation of the division key until there is a selection in the carriage. It also prevents the selection of zero before a significant figure has been selected. No selection, or a zero selection, in division would

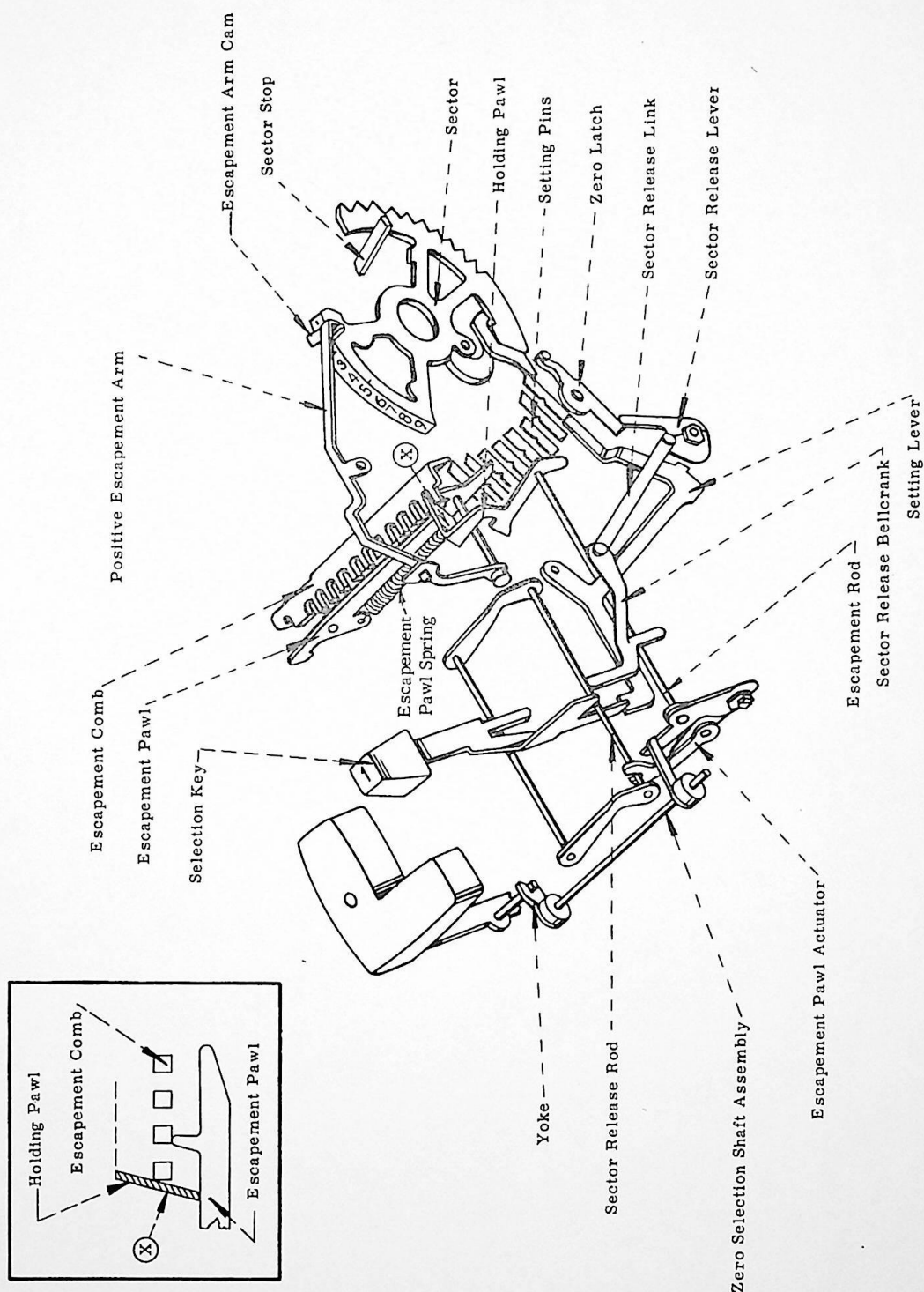
cause the machine to cycle continuously.

When the selection carriage is in home position ear B blocks the counterclockwise rotation of the zero block hook as shown in Sketch 6. Spring N which is stronger than spring T holds ear G of the zero key block against the zero block hook. Ear G is also held in the notch in the main interlock slide to prevent the depression of the division key. Ear Y is held under the zero key as shown in Sketch 6 to prevent selection of a zero.

When the first number is selected, the carriage shifts one order to the left. This moves ear B away from the zero block hook leaving it free to rock down. Spring T pulls the zero key block clockwise moving ear Y away from the zero key and ear G out of the notch in the main interlock slide.

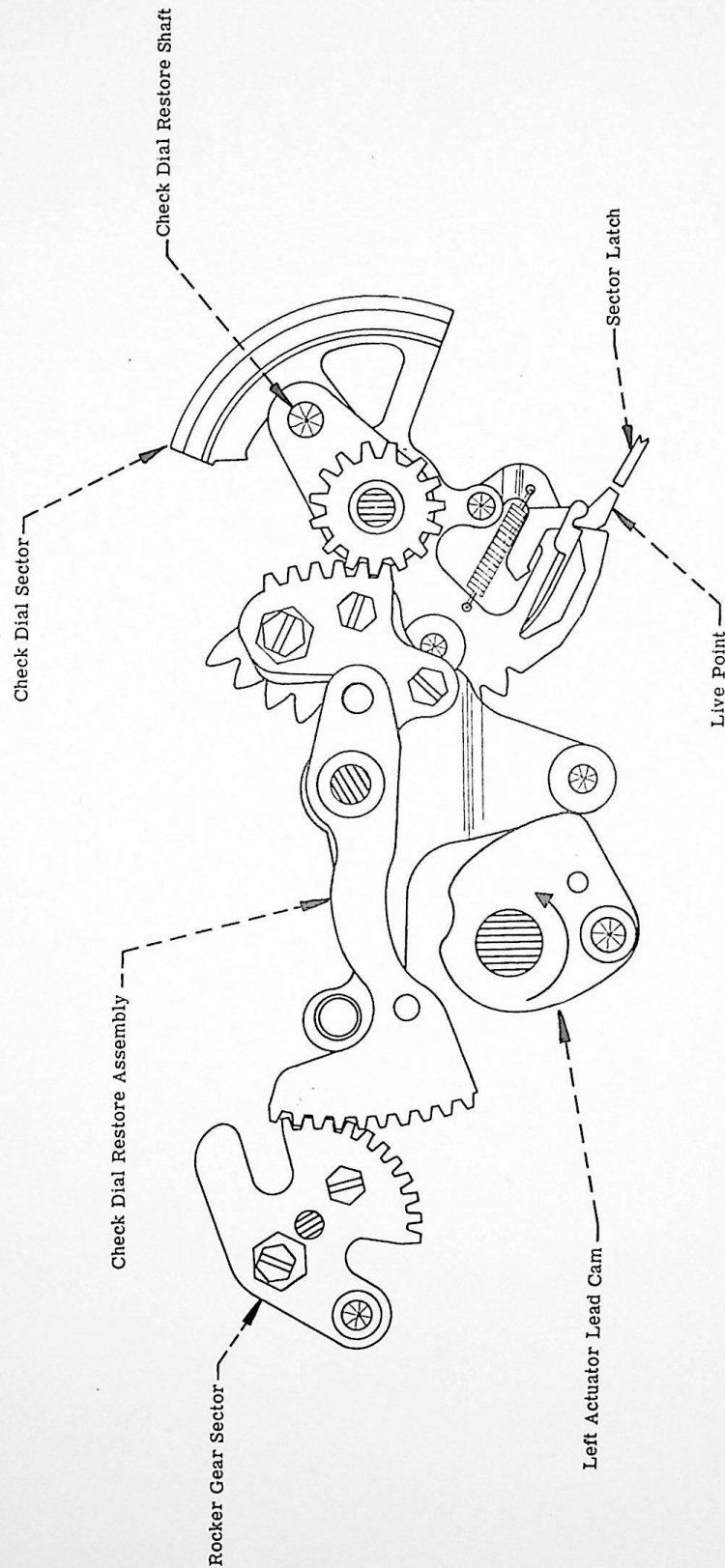
FRIDEN PRINTING CALCULATOR

OPERATIONS - Selection



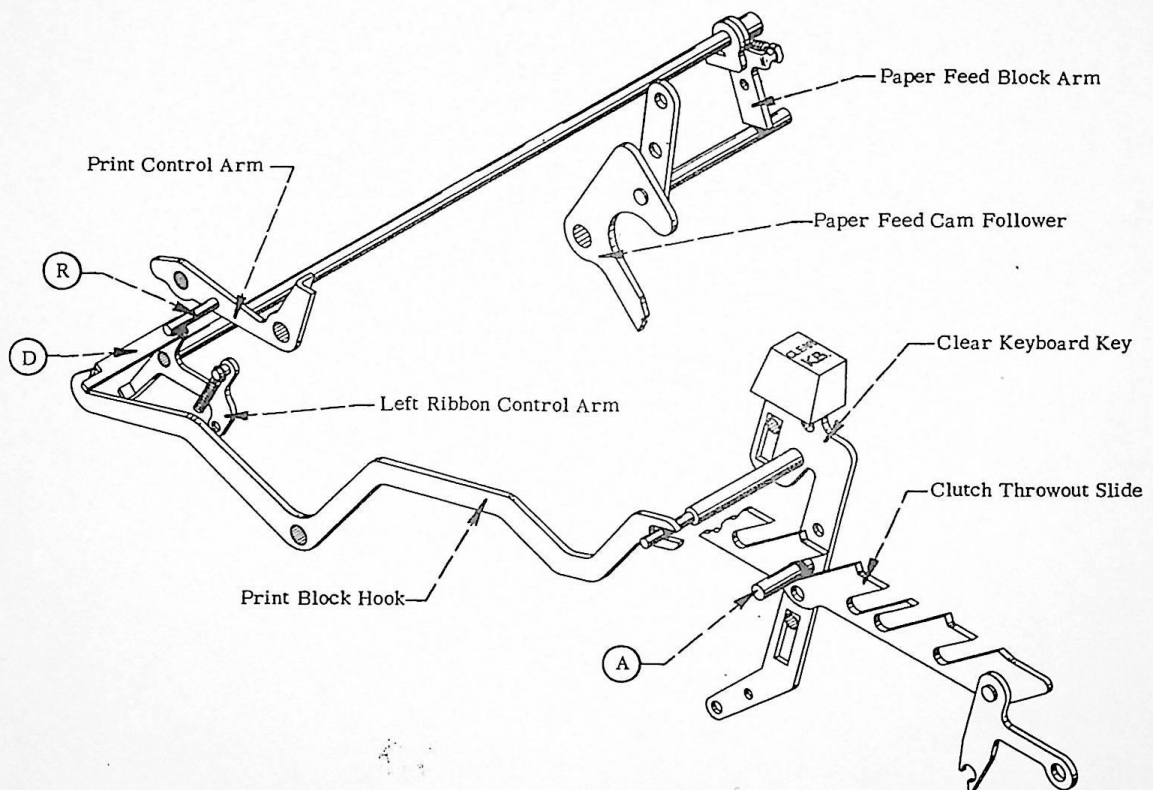
SELECTION
SKETCH 1

FRIDEN PRINTING CALCULATOR
OPERATIONS - Selection



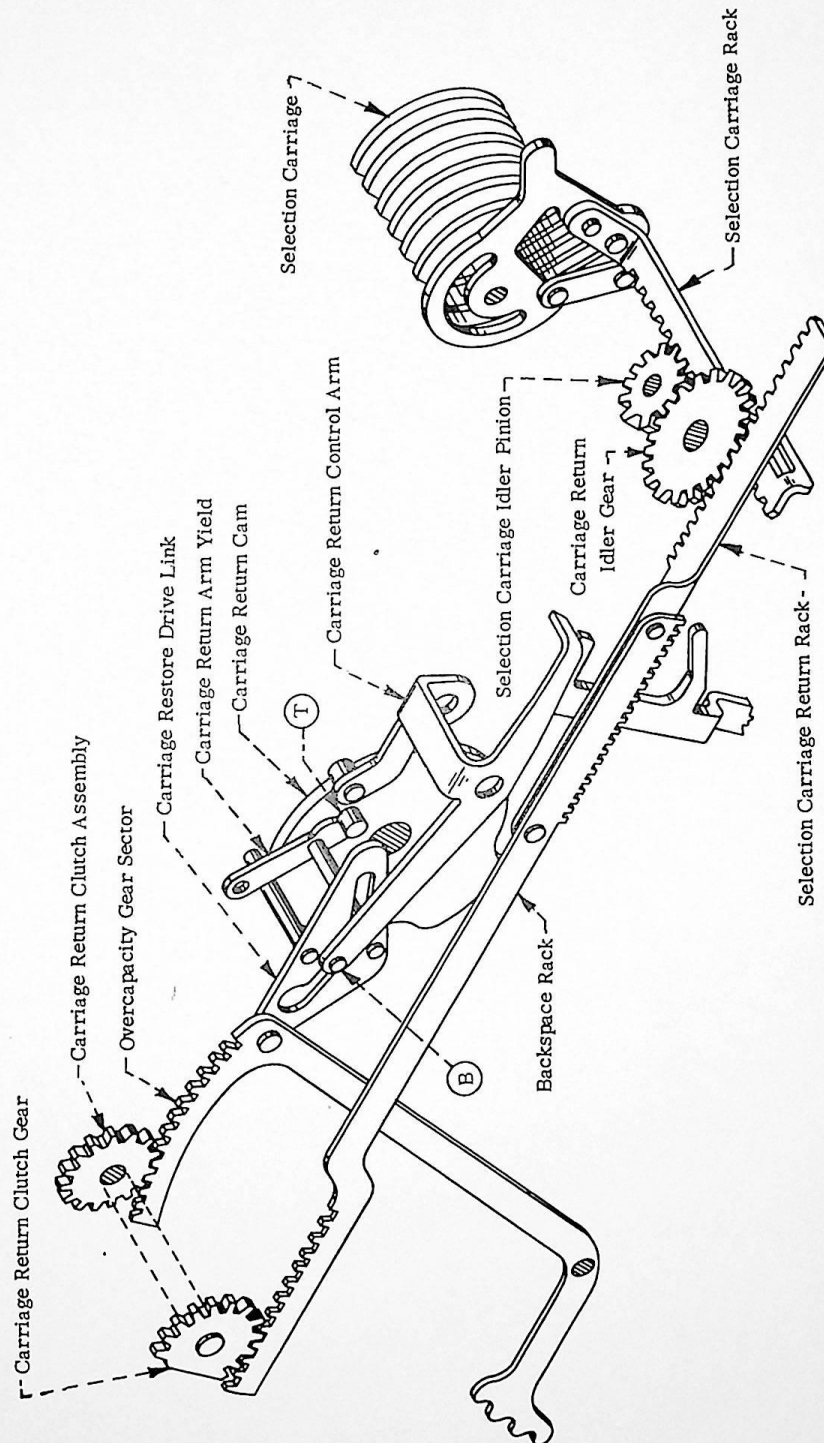
SELECTION
SKETCH 2

FRIDEN PRINTING CALCULATOR
OPERATIONS - Selection

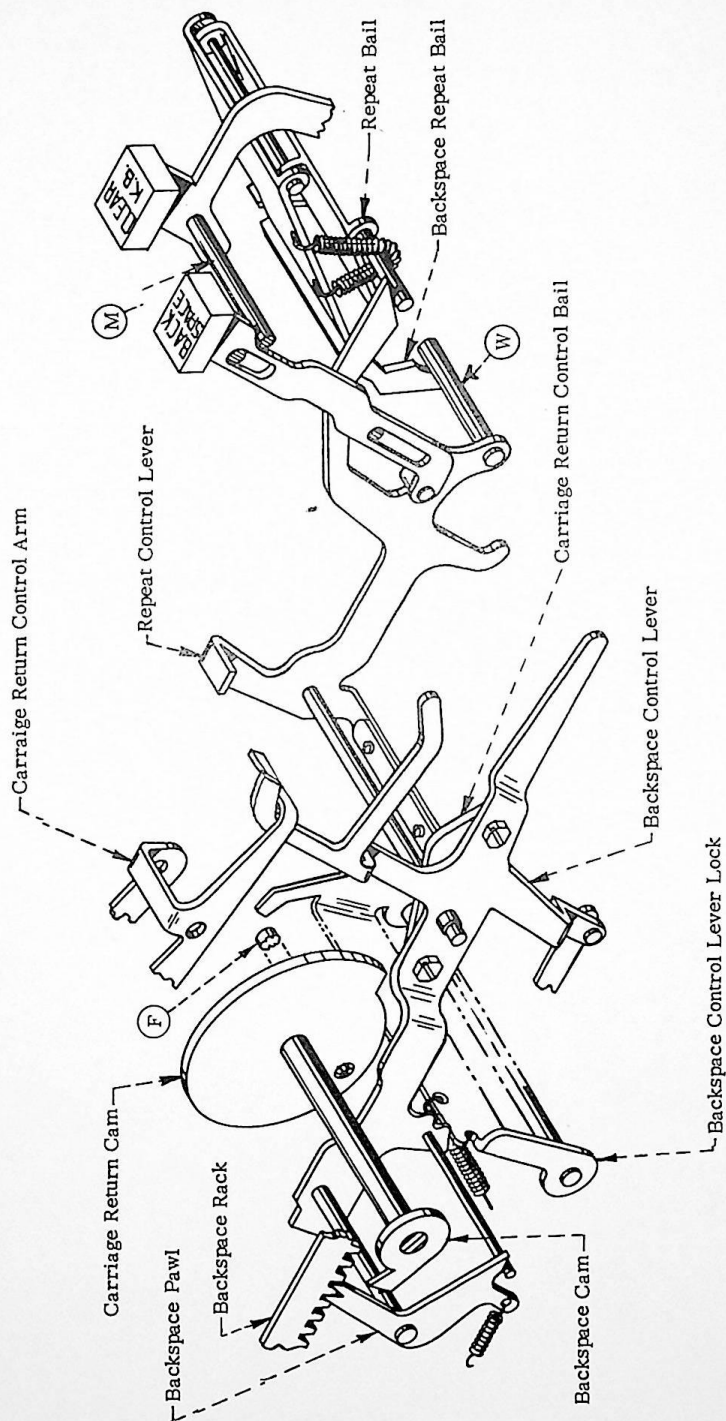


SELECTION
SKETCH 3

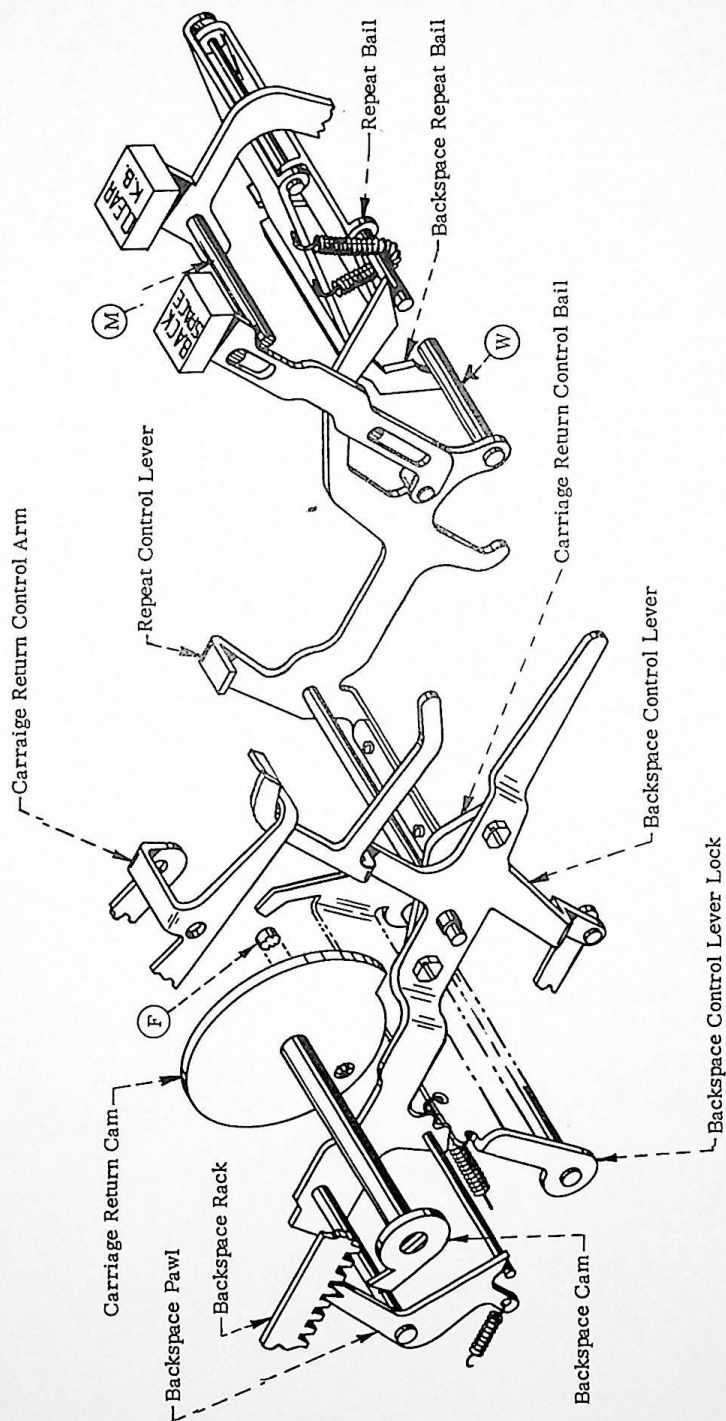
FRIDEN PRINTING CALCULATOR
OPERATIONS - Selection



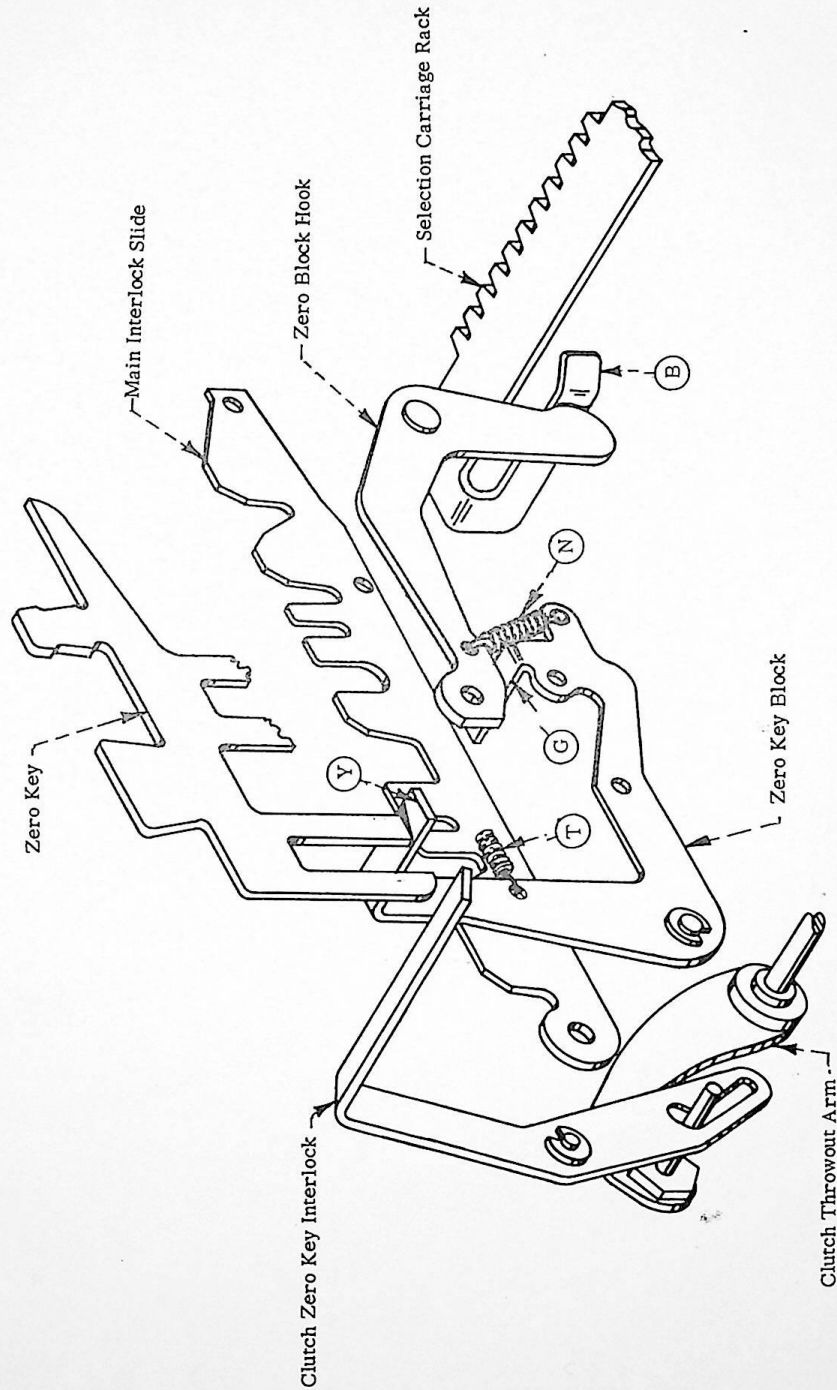
SELECTION
SKETCH 4

SELECTIONSKETCH 5

TP-163SL

SELECTIONSKETCH 5

TP-163SL

SELECTIONSKETCH 6

FRONT PENDANT - Sketch 1

Near the beginning of each machine cycle the front pendant is rocked into engagement with the selection sectors to transfer the selection from the sectors to the actuators.

As the main drive shaft rotates, the pendant control cam (Sketch 1A) rocks the pendant control cam follower clockwise, this pulls the front pendant control link toward the rear of the machine. Rearward movement of the front pendant control link pulls ear A rearward, causing the front pendant assembly to pivot about the upper gear shaft and rock the lower gear into mesh with the selection sectors. The upper gears are always in mesh with the actuators.

PENDANT ALIGNERS

As the lower gears are moving into mesh with the sectors the high of the pendant aligner cam rocks the pendant aligner cam follower (Sketch 1B) counter-clockwise about shaft C. This puts tension on spring Y which pulls the left pendant aligner arm clockwise about shaft E. This raises the aligners into position behind the pendant carriers to lock the lower pendant gears in mesh with the sectors until the actuators have completed their downward stroke. The right pendant aligner arm is fastened to the same shaft as the left pendant aligner arm and rocks with it. During a total or sub-total operation the front pendant is not rocked into mesh with the sectors and the aligners are not raised in front of the carriers.

Before the actuators begin their upward stroke stud T cams the pendant aligner cam follower clockwise about shaft C. This relieves the tension on spring Y and allows the aligners to rotate down to their home position.

REAR PENDANT DRIVE - Sketch 2

As the main drive shaft rotates, the total cam follower (Sketch 2) is spring urged clockwise against the low of the total cam lowering the rear pendant drive hook. When the hook is lowered the tension of spring N on the rear pendant drive bellcrank causes stud R to follow the hook down. This rocks the sub-total cam follower down and allows the rear pendant drive bellcrank to rotate counter-clockwise. The right and the left rear pendant drive levers (only the right one is shown in Sketch 2) are pinned to the same shaft as the rear pendant drive bellcrank. When the rear pendant drive bellcrank is rocked counter-clockwise the rear pendant drive levers are rocked down. Downward movement of the pendant drive levers

cam the studs D, on both sides of the rear pendant assembly, to the rear pulling the rear pendant into engagement with the accumulator feed gears.

ACTUATOR DRIVE - Sketch 3

After the pendants are engaged, further rotation of the main drive shaft causes the actuator drive cams (Sketch 3) to rock the actuator cam follower on the right side, and the selection restore cam follower on the left side clockwise. The gear segments on the ends of the followers rock the left and right rocker gear sectors down. This in turn rocks the actuator drive shaft down against the actuator drive latches. The actuator drive latches carry the actuators down. When an actuator is stopped, as described in the next paragraph, the drive latch on that actuator yields and permits the actuator drive shaft to continue its downward stroke. The actuator drive shaft always completes its full stroke regardless of where any actuator may be stopped.

ENTRY INTO ACCUMULATOR - Sketch 4

When the front pendant is rocked forward (Sketch 1) the lower row of gears engages either a selection sector or the pendant gear block, which extends on either side of the carriage, depending upon the position of the carriage. As the actuators (Sketch 4) are driven down the pendant gears rock the selection sectors up against the sector stop, at which time the actuator drive latch in that order yields. In the orders where the pendant gears are engaged with the pendant gear block the drive latch yields immediately and the actuator does not move.

The upper row of gears on the front pendant is also engaged with the zero foil drum gear and as the selection is transferred from the selection sectors to the actuators by the pendant gear it is also transferred to the print wheels through the idler gears. The upper row of gears on the rear pendant is always in mesh with the actuators, so when it is swung into mesh with the accumulator feed gear the movement of the actuators is transferred to the accumulator feed gears, and then to the accumulator gears.

So on the downward stroke of the actuators the selection is transferred by the front pendant to the actuators and the print wheels and from the actuators to the accumulator by the rear pendant.

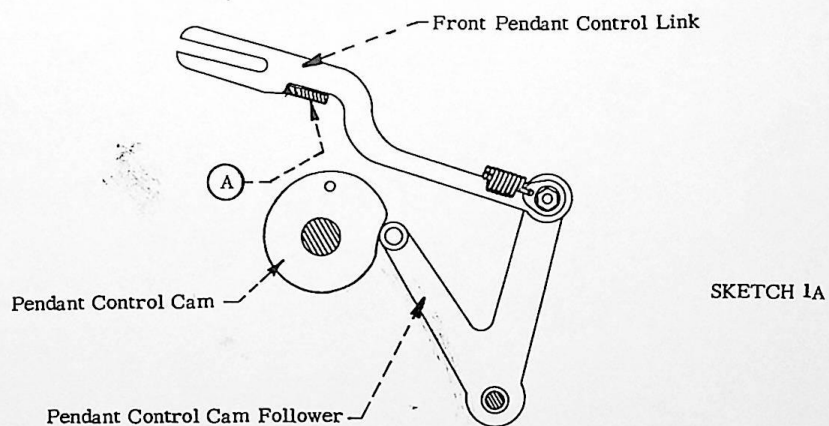
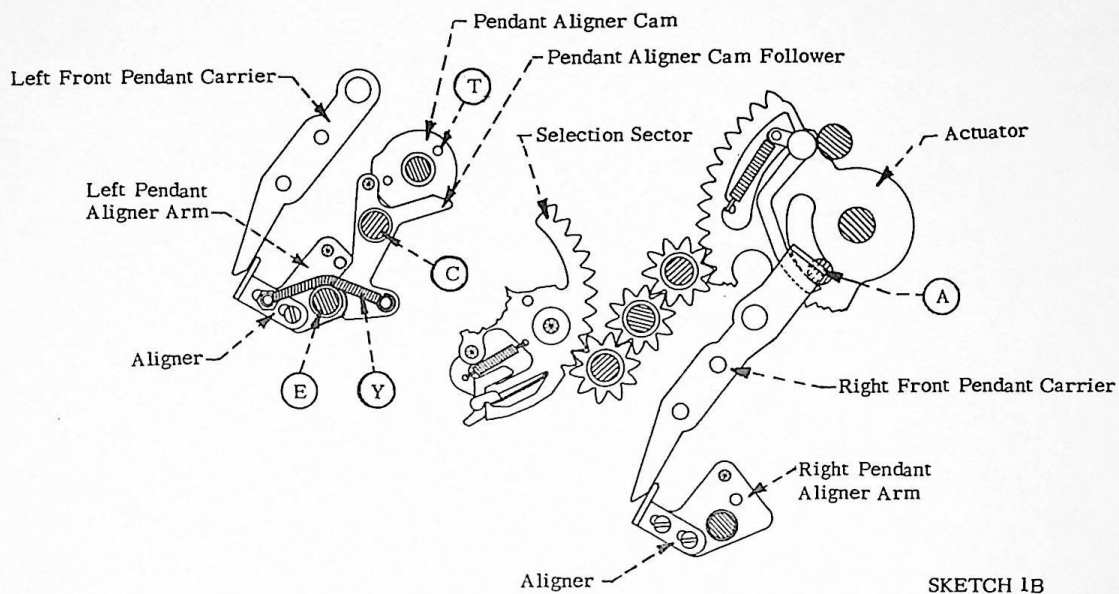
After printing has taken place the front pendant is rocked out of engagement with the sectors and the

OPERATIONS - Actuator

rear pendant is rocked out of mesh with the accumulator by their respective cams on the main drive shaft. The actuator drive shaft is rocked up and the actuators are restored to their home position. The upward movement of the actuators also restores the print wheels to their home position.

Amounts may be entered into and read out of the storage unit sectors by the actuators and multiplier actuator pawls during "To Memory" and "From Memory" operations described in the "Memory Unit" section.

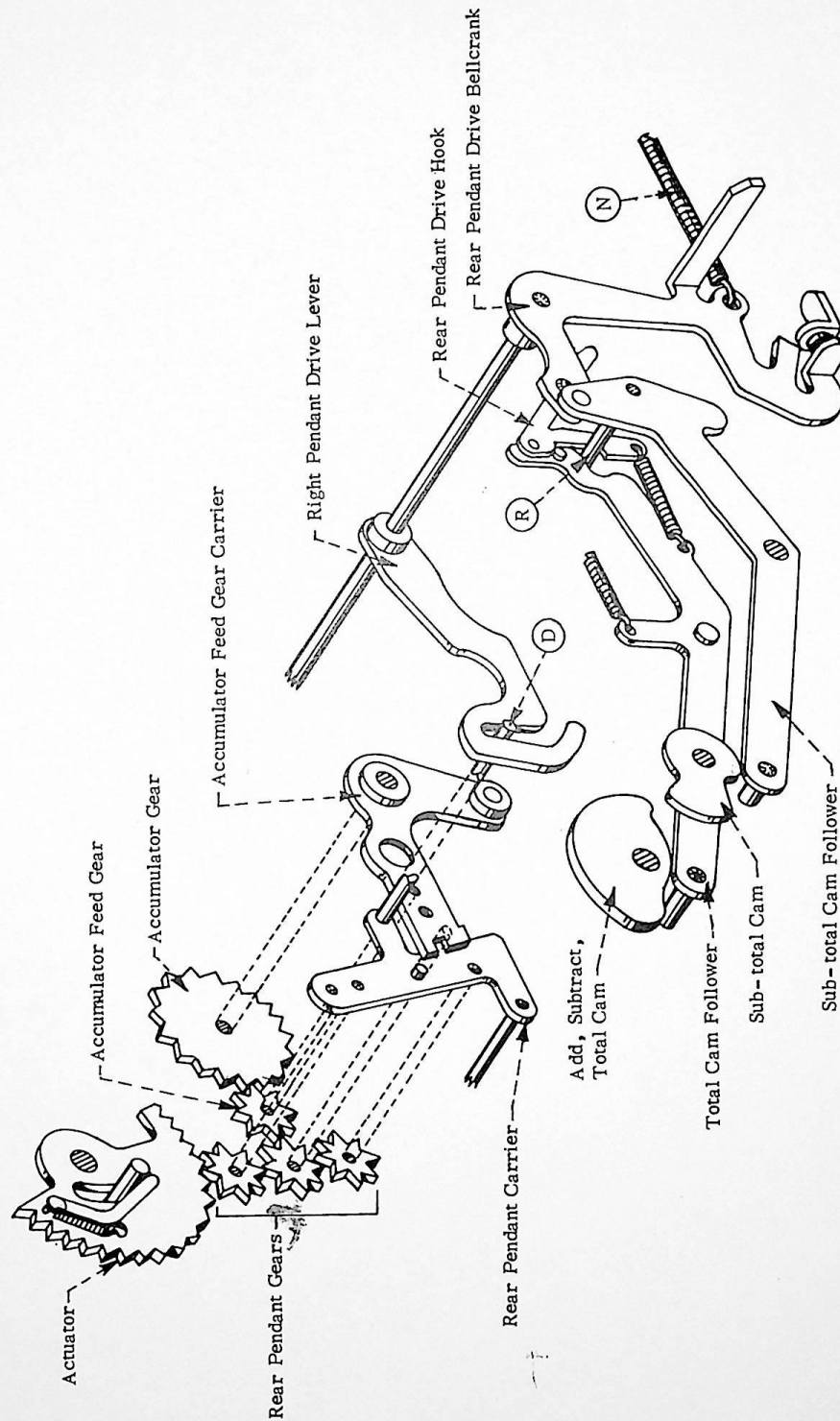
FRIDEN PRINTING CALCULATOR
OPERATIONS - Actuator



ACTUATOR
SKETCH 1

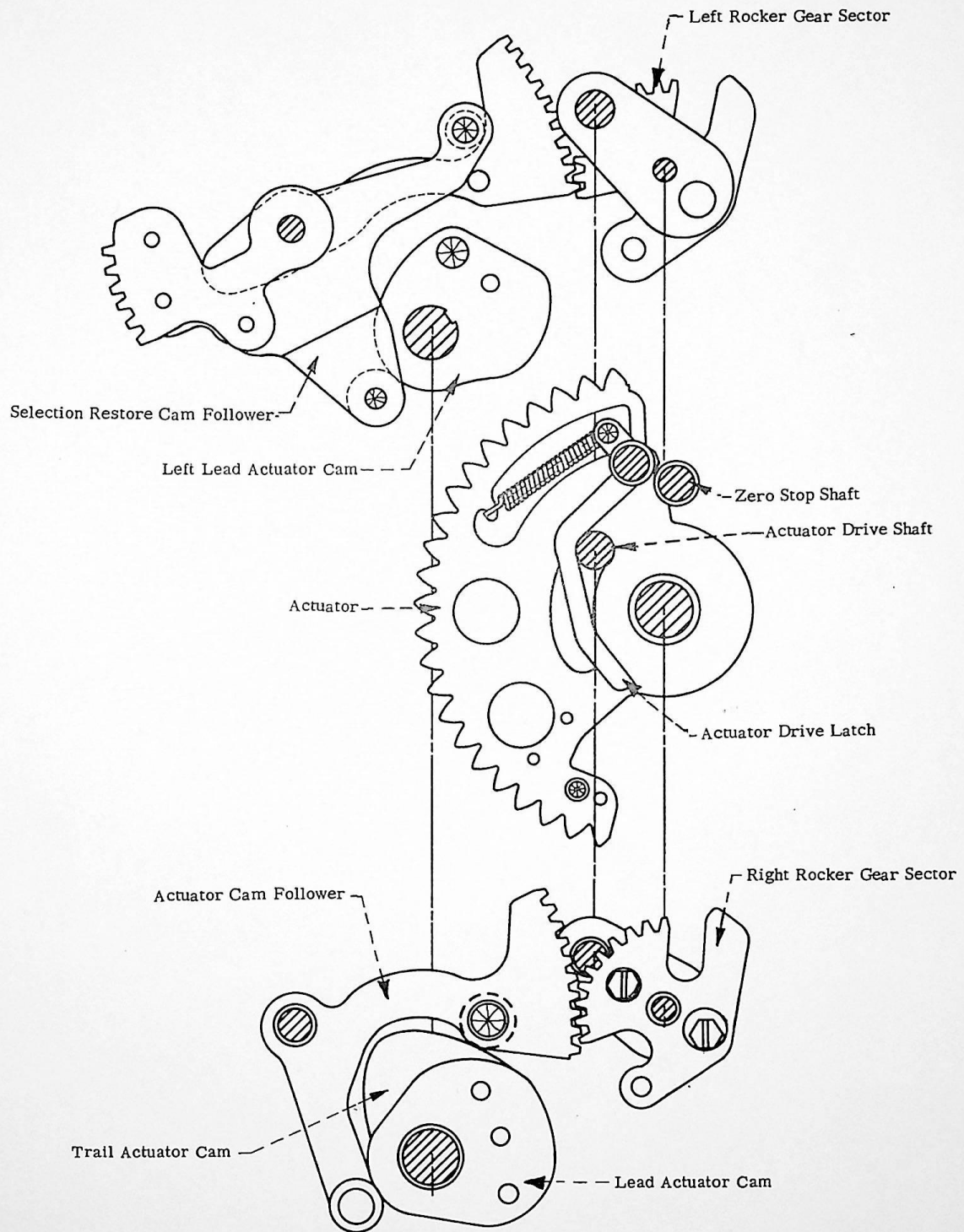
FRIDEN PRINTING CALCULATOR

OPERATIONS - *Actuator*



ACTUATOR
SKETCH 2

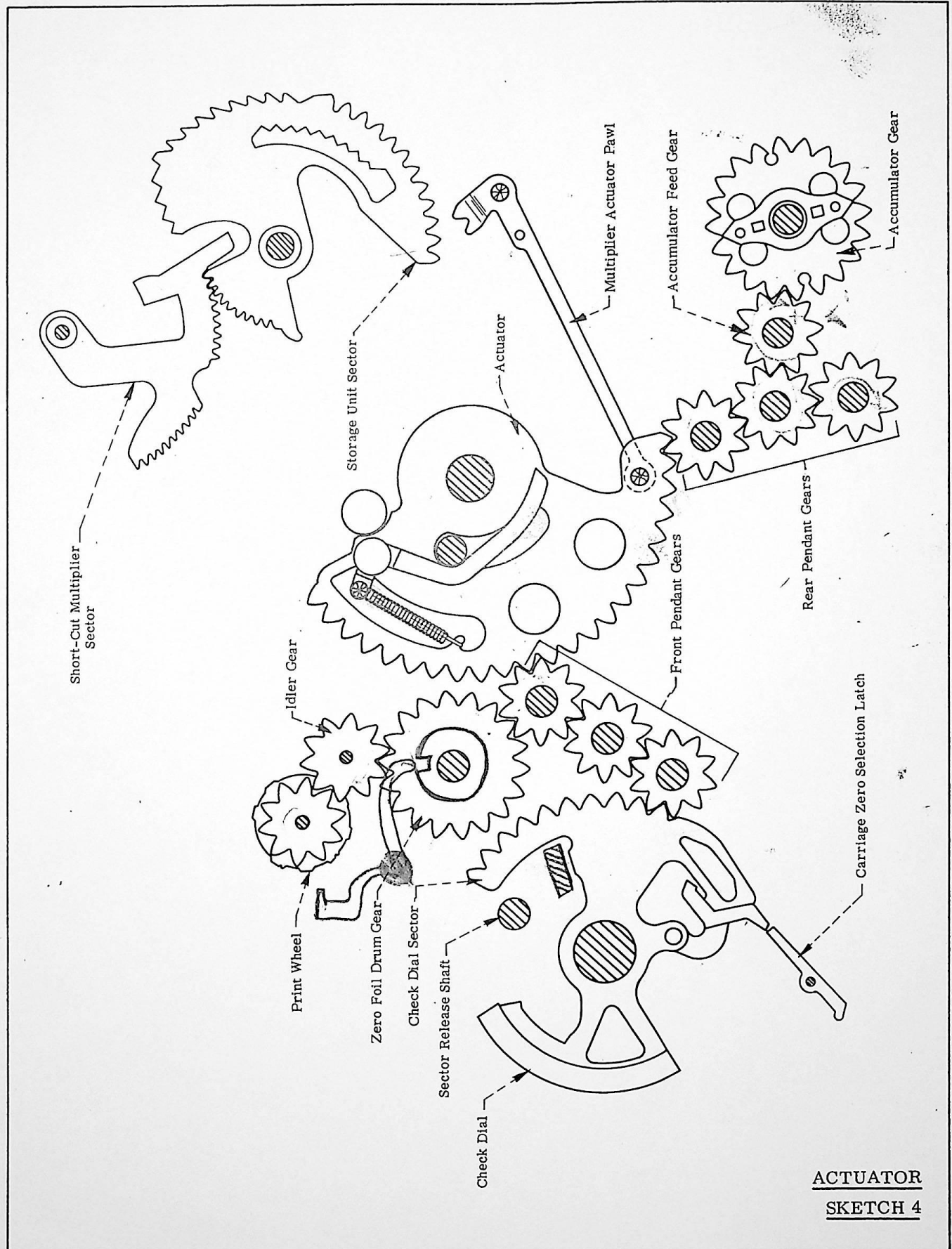
FRIDEN PRINTING CALCULATOR
OPERATIONS - Actuator



ACTUATOR
SKETCH 3

FRIDEN PRINTING CALCULATOR

OPERATIONS - Actuator



ACTUATOR
SKETCH 4

ADD KEY - Sketch 1

Depression of the add key will start the motor, engage the main clutch, clear the check dials, enter the selected figures into the accumulator in a plus direction, and print the figures on the tape with a plus (+) symbol at the right.

Depression of the add key rocks the add clutch throwout fork and the clutch throwout shaft assembly counter-clockwise (Sketch 1). This pulls the right clutch throwout slide forward to start the motor and engage the main clutch as described in the MOTOR and DRIVE section.

Stud A cams the add-subtract control link forward, rocking the add-subtract bellcrank clockwise. This rocks the add-subtract control lever and the add-subtract symbol set counter-clockwise to position ear M for a plus symbol. The symbol printing mechanism is described in the PRINTING section.

Clockwise movement of the add-subtract bellcrank positions the red-black print control so ear Y will be stopped by the form in the arm of the total symbol control. This will allow the ribbon guides to raise the black portion of the ribbon into position for printing.

As the main drive shaft begins to turn, the portion of the feed gear drive cam follower shown in Sketch 1 will rock up. This allows the cycle lock to raise and engage the slot in the add-subtract symbol set to lock the parts in position

through the cycle. The upward movement of the feed gear drive cam follower also raises the feed gear driver. Since the subtract feed gear drive block is held forward of ear D by stud J in the slot in the add-subtract symbol set the feed gear carrier is not cammed down. This leaves the accumulator feed gears in position to mesh with the middle row of rear pendant gears.

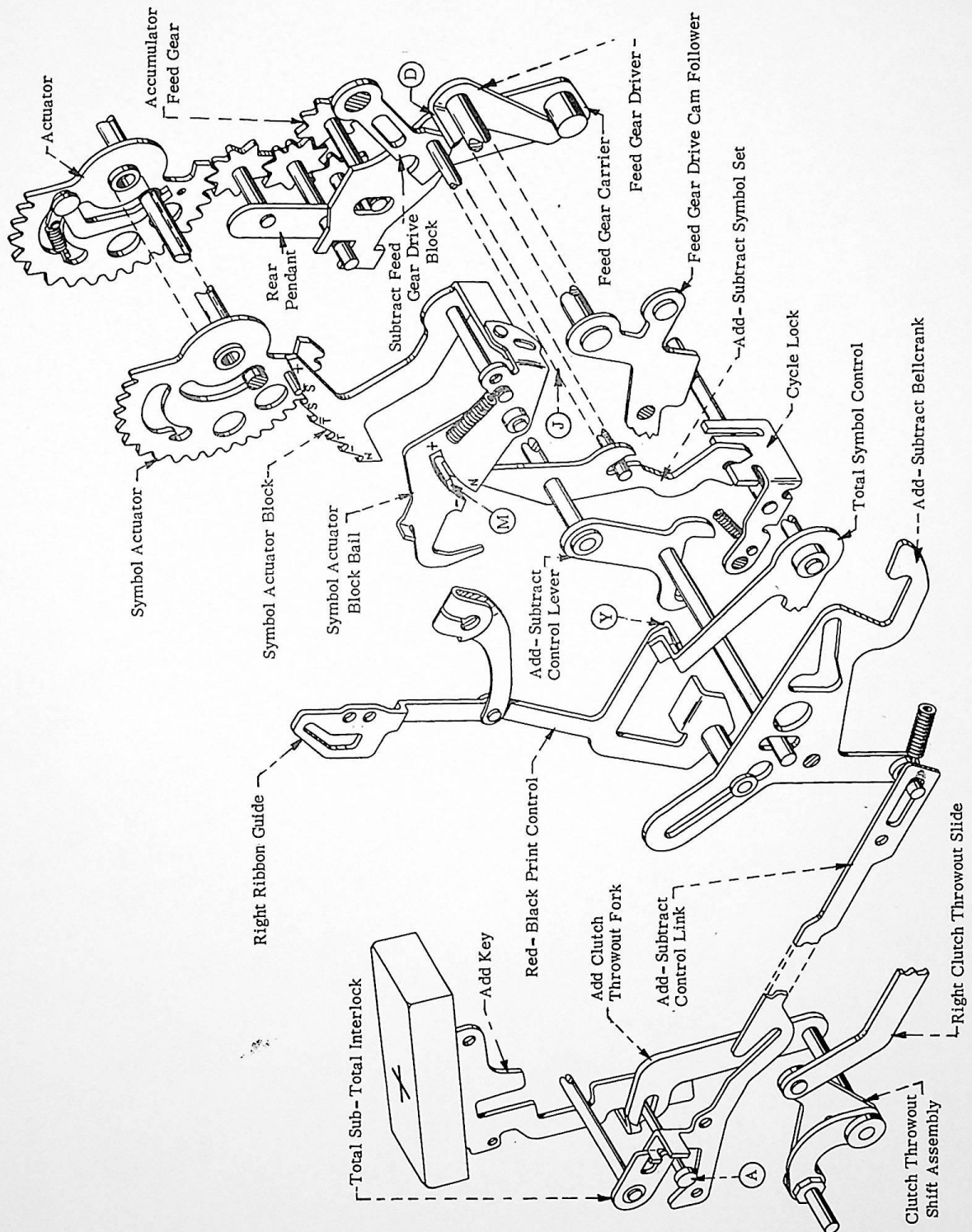
After the controls have been set, the front pendant will be rocked into engagement with the check dial sectors and the rear pendant rocked into engagement with the accumulator feed gears. The actuators will be driven downward clearing the check dial sectors, and entering the figures into the accumulator and the print wheels. This action is described in the ACTUATOR section.

After printing has taken place as described in the PRINTING section the pendants will be rocked out of engagement with the check dial sectors and the accumulator feed gears. The actuators and the print wheels will be restored. The selection carriage will be restored.

Near the end of the cycle the feed gear drive cam follower is rocked down, rocking the cycle lock down, leaving the controls free to be restored. The single cycle mechanism, described in the MOTOR and DRIVE section, will terminate the operation and release the depressed add key. This allows the add-subtract control link, the add-subtract bellcrank, and the add-subtract symbol set to be restored under spring tension.

FRIDEN PRINTING CALCULATOR

OPERATIONS - Add Key



ADD KEY
SKETCH 1

SUBTRACT KEY - Sketch 1

Depression of the subtract key will start the motor, engage the main clutch, clear the check dials, enter the selected figures into the accumulator in a minus direction, and print the figures on the tape in red with a minus (-) symbol at the right.

Depression of the subtract key will rock the subtract bellcrank (Sketch 1) clockwise. Stud B will rock the clutch throwout fork and the clutch throwout shaft assembly counter-clockwise. This pulls the right clutch throwout slide forward to start the motor and engage the main clutch as described in the MOTOR and DRIVE section.

The subtract bellcrank also causes stud R to rock the add-subtract carrier link and the add-subtract control link forward. This rocks the add-subtract bellcrank clockwise, which in turn, rocks the red-black print control to lift ear N above the form in the arm of the total symbol control. This will allow the ribbon guides to raise the red portion of the ribbon into position to print.

Clockwise movement of the add-subtract bellcrank rocks the add-subtract control lever and the add-subtract symbol set counter-clockwise to position ear E for a minus symbol. The symbol printing mechanism is described in the PRINTING section.

As the main drive shaft begins to turn, the portion of the feed gear drive cam follower shown in Sketch 1 will rock up. This allows the cycle lock to raise in front of the add-subtract sym-

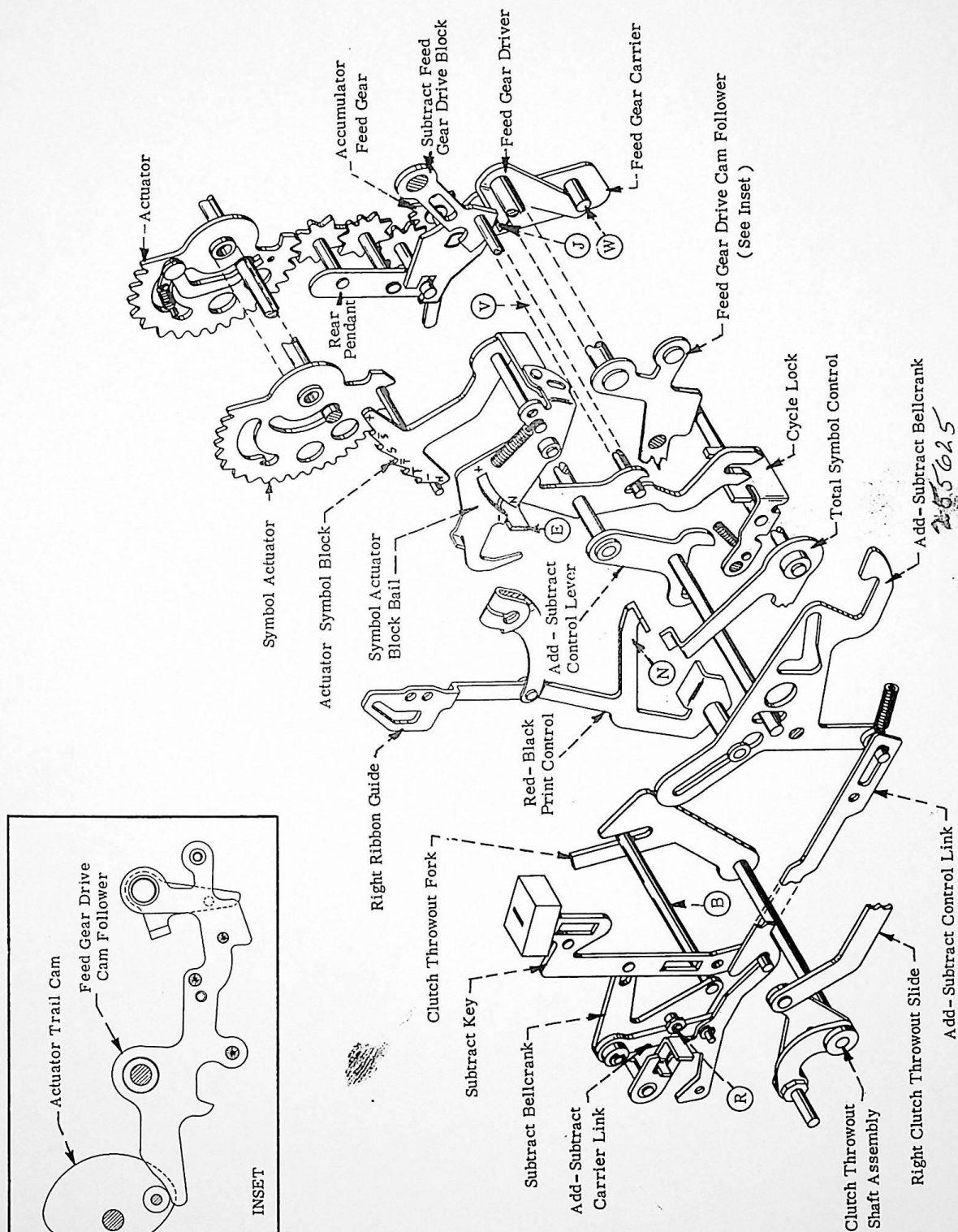
bol set to lock the parts in place through the cycle. The upward movement of the feed gear drive cam follower also raises the feed gear driver. When the add-subtract symbol set was rocked clockwise stud V and the subtract feed gear drive block were rocked rearward by the cam shaped slot in the add-subtract symbol set. This places the subtract feed gear drive block over ear J. As the feed gear cam follower raises, the feed gear driver is rocked counter-clockwise against roller W. This rocks the feed gear carrier counter-clockwise to place the accumulator feed gears in a position to mesh with the lower row of rear pendant gears.

After the controls have been set, the front pendant will be rocked into engagement with the check dial sectors and the rear pendant rocked into engagement with the accumulator feed gears. The actuators will be driven downward clearing the check dial sectors, and entering the figures into the accumulator and the print wheels. This action is described in the ACTUATOR section.

After printing has taken place as described in the PRINTING section the pendants will be rocked out of engagement with the check dial sectors and the accumulator feed gears. The actuators and the print wheels will be restored. The selection carriage will be restored. Near the end of the cycle the feed gear drive cam follower is rocked down, rocking the cycle lock down, leaving the controls free to be restored. The single cycle mechanism described in the MOTOR and DRIVE section will terminate the operation and release the depressed subtract key. This allows the add-subtract bellcrank and the add-subtract symbol set to be restored by spring tension.

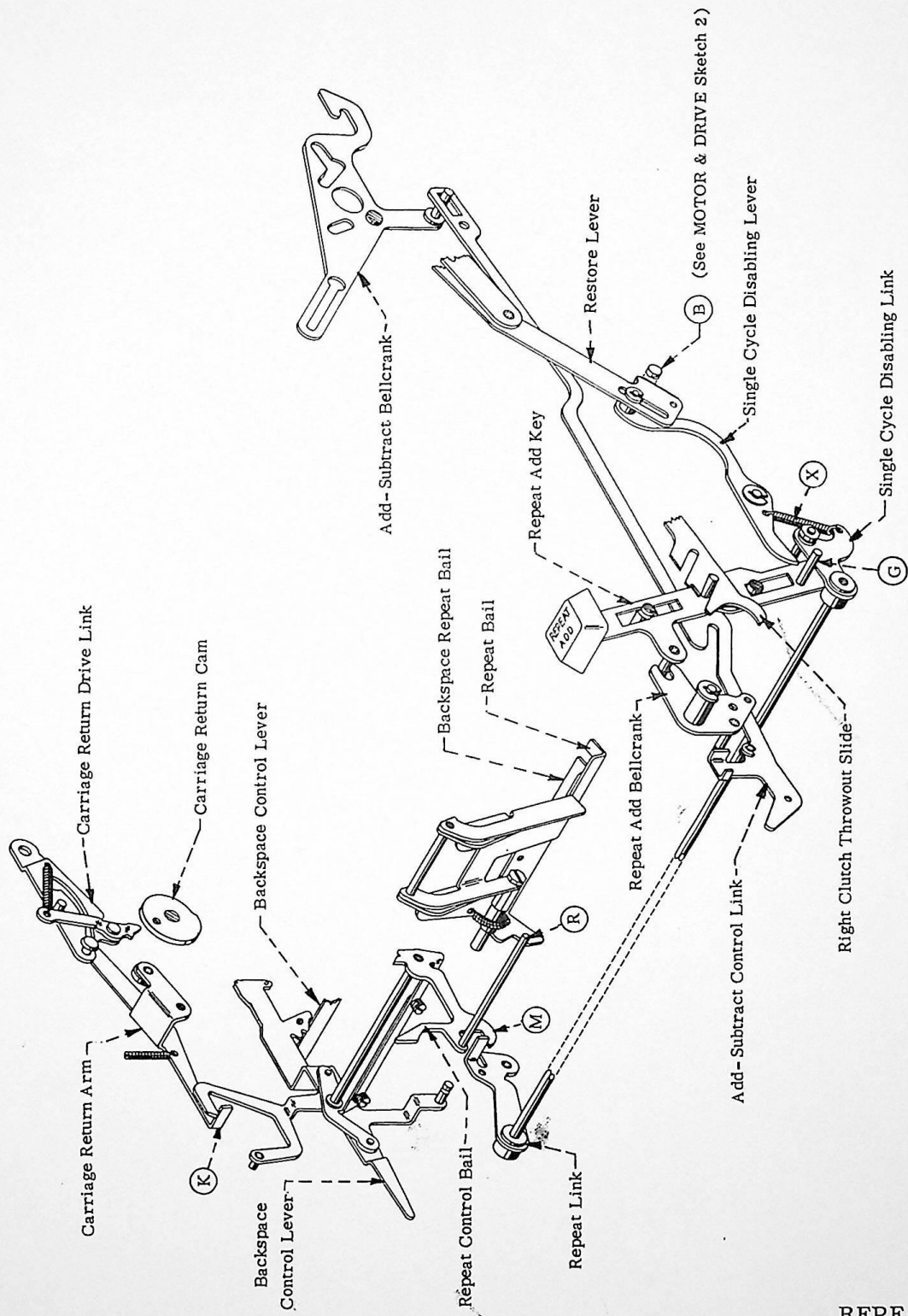
FRIDEN PRINTING CALCULATOR

OPERATIONS - Subtract Key



SUBTRACT KEY

SKETCH 1



REPEAT KEY
SKETCH 1

NON ADD KEY - Sketch 1

Depression of the non add key will start the motor, engage the main clutch, clear the check dials, and print the selected figures on the tape with an "#" at the right. The selected figures will not be entered into the accumulator.

Depression of the non add key pulls the right clutch throwout slide forward to start the motor and engage the main clutch as described in the MOTOR and DRIVE section.

The add-subtract bellcrank, the add-subtract control lever, and the add-subtract symbol set remain in their home position during the non add cycle.

Ear A remains under the surface of the symbol actuator block bail indicated by the "#" in Sketch 1, so the symbol actuator block will be set to stop the symbol actuator for a "#" symbol. The symbol printing mechanism is described in the PRINTING section.

Since the add-subtract bellcrank does not rock, ear Z of the red-black print control remains under the form in the arm of total symbol control so the ribbon will be raised to print in the black portion. As the main drive shaft begins to

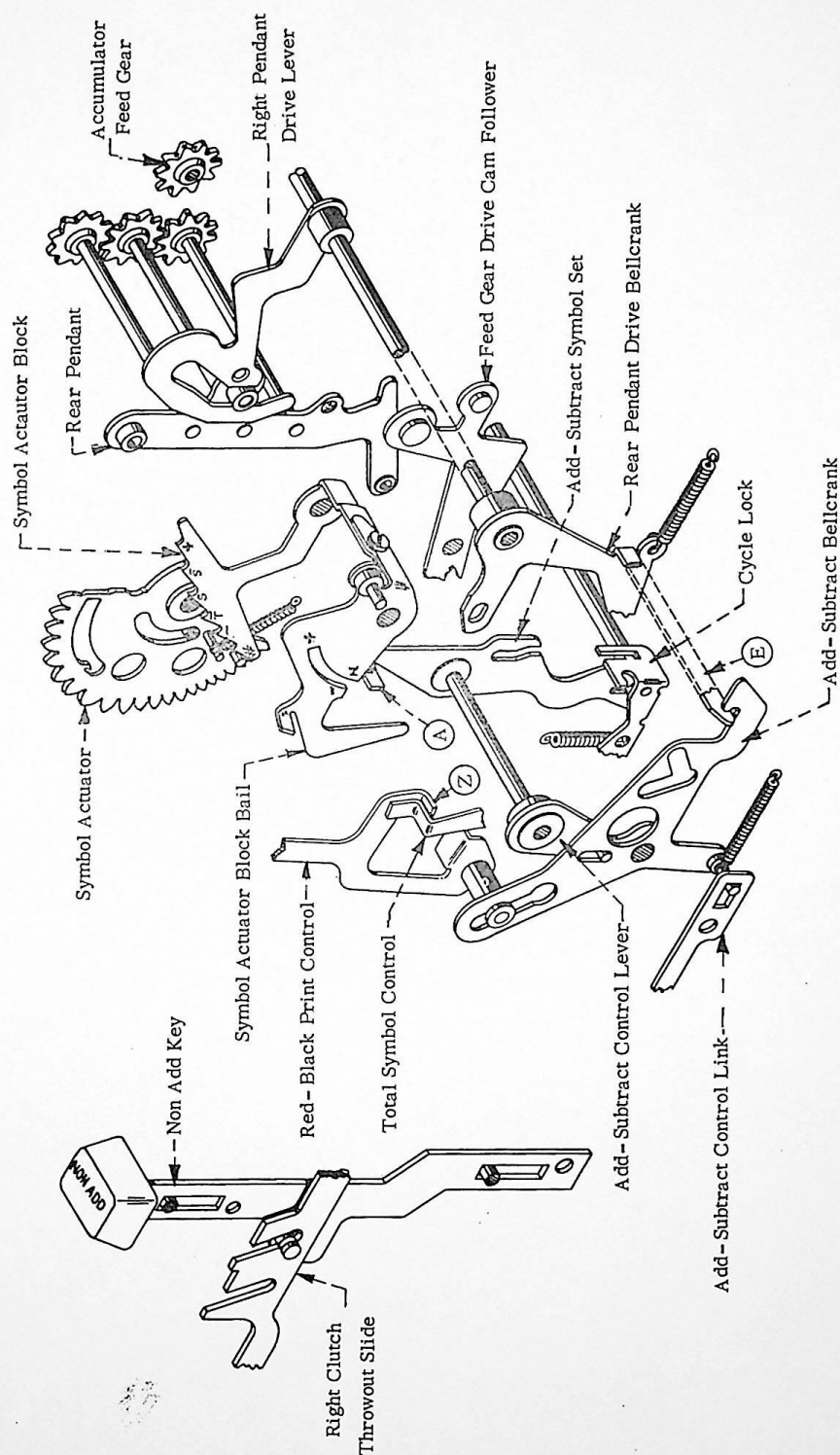
turn, the rear portion of the feed gear drive cam follower rocks up allowing the cycle lock to rock up behind the add-subtract symbol set and lock the controls in place through the cycle.

The front pendant is rocked into engagement with the check dial sectors as described in the ACTUATOR section.

The rear pendant is not rocked into engagement with the accumulator feed gears because ear E of the rear pendant drive bellcrank is held by the hook on the add-subtract bellcrank, so the pendant drive levers cannot rock down.

After the front pendant is engaged the actuators will be rocked down clearing the check dials and entering figures into the print wheels. Printing will take place. The front pendant will be rocked out of engagement with the check dial sectors. The actuators and the print wheels will be restored. The selection carriage will be restored.

Near the end of the cycle the feed gear drive cam follower rocks the cycle lock down to allow the controls to restore. The single cycle mechanism, described in the MOTOR and DRIVE section, will terminate the operation and release the depressed non add key.



NON ADD KEY

SKETCH 1

DESCRIPTION - Sketches 1 & 2

The accumulator provides a means for storing the results of various operations so a total or sub-total may be obtained when desired. The accumulator consists of seventeen similiar orders. The first, or number one, order is at the right side of the accumulator and the number seventeen order is at the left. A typical order of the accumulator is shown in Sketch 1. The main parts of the accumulator are described briefly below.

ACCUMULATOR GEAR: This is a twenty tooth gear with a transfer cam attached. The position of the transfer cam with respect to the transfer live-points determines which figure is stored in that order. Plus values are entered into the accumulator by rotating the gear counter-clockwise. Minus values are entered by rotating the gear clockwise. Sketch 2 shows the position of the gear for the figures zero to nine. Notice that each position of the gear may indicate either a plus or minus value. The direction in which the gear is rotated when a total is taken determines whether the positive or the negative value is read out. During a total operation the gears are rotated in the opposite direction, back to zero, that is, for a positive total the gears are rotated clockwise and for a negative total or credit balance, the gears are rotated counter-clockwise. During a total operation the transfer live-points (Sketch 1) are blocked and serve to stop the rotation of the accumulator gears at their zero position.

FEED GEAR: Values are entered in to the accumulator by means of the feed gear. The feed gears are mounted on a carrier which permits them to mesh with either the middle or the lower row of rear pendant gears. For a positive entry the feed gears remain in their normal position and engage the middle row of gears as the pendant is rocked into mesh with the feed gears. For a negative entry the feed gears are rocked down to engage the lower row of pendant gears. During a total operation the position of the feed gears is opposite that for entries, that is, for a positive total the feed gears are in mesh with the lower row of pendant gears and for a negative total with the middle row of pendant gears.

TRANSFER LEVERS: Each accumulator gear only has positions for the values zero to nine, if successive entries cause a value greater than nine it is necessary to have a transfer or "carry" of one to the gear in the order to the left. As the point C of the transfer cam passes the plus transfer live-point going in a plus, or counter-clockwise, direction the plus transfer lever will be cammed out and ear A will release the plus transfer pawl in the next order to the left. The same action takes

place with the minus transfer lever when the gear is rotating in a minus, or clockwise, direction.

ACCUMULATOR DETENT: In order to insure the proper mesh of the feed gears with the pendant gears and to eliminate the possibility of the transfer live-points, as they are being restored, coming to rest on the points of the transfer cam. The accumulator detent retains the gear in proper tooth alignment at all times.

POSITIVE ENTRY - Sketch 3

Positive entries are made by rotating the accumulator gears in a counter-clockwise direction (as seen from the right side of the machine). For positive accumulator entries the accumulator feed gears are held in mesh with the middle row of gears in the rear pendant. The feed gear carrier (Sketch 3) is normally in position for a positive entry, so it is not moved. The slots in the ends of the feed gear carrier engage the protruding ends of the pendant gear shafts to lock the gears in mesh during accumulator entries. As the actuator rocks down, the figure from the selection sector is transferred thru the rear pendant gear and the accumulator feed gear to the accumulator gear, rotating it counter-clockwise a number of teeth corresponding to the figure in the selection sector in that order.

NEGATIVE ENTRIES - Sketch 4

For negative entries the accumulator feed gears must be in mesh with the lower row of rear pendant gears. This causes the accumulator gears to rotate in a clockwise direction.

Each machine cycle the feed gear drive cam follower is rocked counterclockwise by the feed gear drive stud on the actuator trail cam. During any minus operation, such as subtraction, the shaft assembly carrying the add-subtract symbol set is rocked counterclockwise as shown in Sketch 4. The slot in the add-subtract symbol set cams stud N towards the rear of the machine. This rocks the subtract feed gear drive block into a position to intercept ear A of the feed gear driver. As the feed gear drive cam follower is rocked counterclockwise, the pivot point (stud S) for the feed gear driver is rocked upward. However, since the subtract feed gear drive block is over ear A, the feed gear driver will be rocked counterclockwise against roller D. This rocks the feed gear carrier down placing the feed gears in position to mesh with the lower row of gears on the rear pendant. As the rear pendant is rocked into mesh with the feed gears, the slots in front of the feed gear carriers engage the protruding ends of the lower pendant gear shaft to hold the gears in mesh while the accumulator entry is taking place.

TRANSFER - Sketch 5

When successive amounts, added or subtracted, cause the accumulator gear to rotate further than nine teeth, it is necessary to provide a transfer of one to the next order to the left. Sketch 6A shows the accumulator gear with a plus nine stored. If a one is added, the accumulator gear will be rotated one tooth counter-clockwise. As Point A of the transfer cam contacts live point B, the plus transfer release lever will be cammed outward. Ear C will release the plus transfer pawl D in the order to the left. The transfer pawl D will be spring urged in toward the accumulator gear in that order, but it will be blocked by the transfer control shaft at this time. When Point A contacts live point B of the plus transfer lever, point E will contact the live point of the minus transfer release lever, but because of the direction of rotation this live point will yield to let the transfer point pass and will not release the minus transfer release pawl. If the gears were rotating clockwise, as in a subtract operation, the minus transfer release lever would be cammed out to release the minus transfer pawl and live point on the plus transfer release lever would yield.

Example: Assume a total had been taken, leaving the accumulator clear with all gears at zero. If a five is entered in the first order and the add key depressed ".05" will be printed on the tape and the accumulator gear in the first order will be rotated five teeth counter-clockwise. If a seven is now entered and the add key again depressed, ".07" will be printed on the tape and the accumulator gear in the first order will be rotated seven teeth. Since the accumulator gear in the first order had previously been rotated five teeth, seven more teeth will carry the transfer point A past the live point B and cause a transfer of one to the second order. The gear in the first order will rotate two more teeth after the transfer occurs leaving the accumulator with the first order gear at "2" and the plus transfer pawl released in the second order. After the rear pendant is rocked out of mesh with the feed gears, the roller on the transfer control arm (Sketch 6B) will drop to the low of the cam, rocking the transfer control bails in, allowing any transfer pawls released during the cycle to be spring urged in and rotate their accumulator gears one tooth. This will place the second order gear at "1". If a total is taken now ".12T" will be printed on the tape.

At the beginning of every machine cycle the transfer control arm is raised to the high of the cam, rocking the transfer control bails out to restore any transfer pawls released during the previous cycle.

ANTI-REBOUND PAWL

As the transfer pawls are being restored near the beginning of each machine cycle a heavy load is placed on the main drive shaft. Due to the shape of the transfer control cam the main drive shaft could be driven backward by springs on the 34 transfer pawls. The anti-rebound pawl (Sketch 6C) acts against the anti-backup cam to prevent the main drive shaft from backing up. As the transfer pawl restore action begins, the anti-rebound pawl drops off the high of the total control cam step by step to prevent the main drive shaft from backing up at any point during the transfer pawl restore operation.

TRANSFER LATCH STOP BAIL - Sketch 6

The transfer latch stop bail prevents the release of plus transfer pawls during minus transfer operations. Since the plus transfer levers are at the bottom of the accumulator, gravity and the camming action as the live-points yield during a minus transfer could cause a plus transfer lever to be released. As the feed gear carrier is rocked down to engage the lower row of rear pendant gears for a minus entry into the accumulator roller A cams the transfer latch release bail up against the plus transfer latches to prevent their moving down.

No transfer latch stop bail is necessary for the minus transfer release levers since gravity tends to hold them in place due to their position at the top of the accumulator.

FUGITIVE ONE TRANSFER - Sketch 7

There are two sides to the accumulator, a plus side and a minus side. This is necessary so the machine can print minus, credit balance, totals correctly. Both sides have positions for "0" to "9", so there is a plus zero and a minus zero as shown in Sketch 2. To compensate for the extra zero position it is necessary to move the accumulator gear an extra tooth when going from a plus to a credit balance total or from a credit balance to a plus total. For Example: After a credit balance (minus) total, all the accumulator gears would stand at "0" on the minus side and at "9" on the plus side. If a total was taken now, ".00T" would be printed on the tape in red. If a one were now added, the accumulator gear in the first order would be rotated one tooth counter-clockwise. This would cause a "transfer wave" to the left, leaving all the gears at zero on the plus side and nine on the minus side. If a total was taken with the accumulator in this condition, ".00T" would

be printed in black, and not ".01T" which would be the correct figure. To provide the correct answer, the "fugitive one mechanism" on the plus side of the accumulator operating from the seventeenth order will cause a transfer in the first order, moving that gear an extra tooth counter-clockwise. This transfer action occurs whenever the accumulator goes from a minus to a plus. When the accumulator goes from a plus to a minus condition a similar fugitive one transfer takes place on the minus side of the accumulator, moving the gear in the first order an extra tooth clockwise.

The inset on Sketch 8 shows the position of the accumulator wheels after a credit balance total. The points of the transfer cams stand at "0" on the minus side and "9" on the plus side. If a "1" is added, the accumulator gear in the first order will be rotated one tooth counter-clockwise as shown in Sketch 8. As the gear rotates, the transfer point will cam the plus transfer release lever out, releasing the plus transfer pawl in the second order. Since the accumulator gear in the second order also is "9" on the plus side, when the transfer bails allow the transfer to take place the transfer point on that gear will cam the trans-

fer release lever out, causing a transfer to the third order, and so on, to the seventeenth order. The transfer release lever in the seventeenth order is connected by the fugitive one bail to an arm which latches the transfer pawl in the first order. When the transfer release lever in the seventeenth order is cammed out, the fugitive one bail releases the transfer pawl in the first order which moves the first order accumulator gear an extra tooth, from plus zero to plus one. If a total were taken now, the correct answer ".01T" would be printed.

If a plus total had previously been taken, the accumulator gears would be at "0" on the plus side and "9" on the minus side. If a "1" were subtracted the fugitive one transfer would take place as described above except on the minus side of the accumulator.

Anytime the total stored in the accumulator changes from plus to credit balance or from credit balance to plus, it is necessary to have a fugitive one transfer to compensate for the extra zero position.

EXAMPLE:

17	16		7	6	5	4	3	2	1	
0	0		0	0	0	0	0	0	0	
0	0		0	6	0	0	0	0	0	#6 rotated 6 teeth counter-clockwise
				7						#6 rotated 7 teeth clockwise
9	9		9	9						ON PLUS SIDE
				8	9	9	9	9	9	transfer from #6 to #7 and so on to #17
										Fugitive one transfer to #1 causes transfer to #2 and so on back to #6 where trans. stops because pawl is tripped.
				1	0	0	0	0	0	Credit balance indicator is moved to minus by fugitive one trans. so read-out is from minus side.

CREDIT BALANCE INDICATOR - Sketch 8

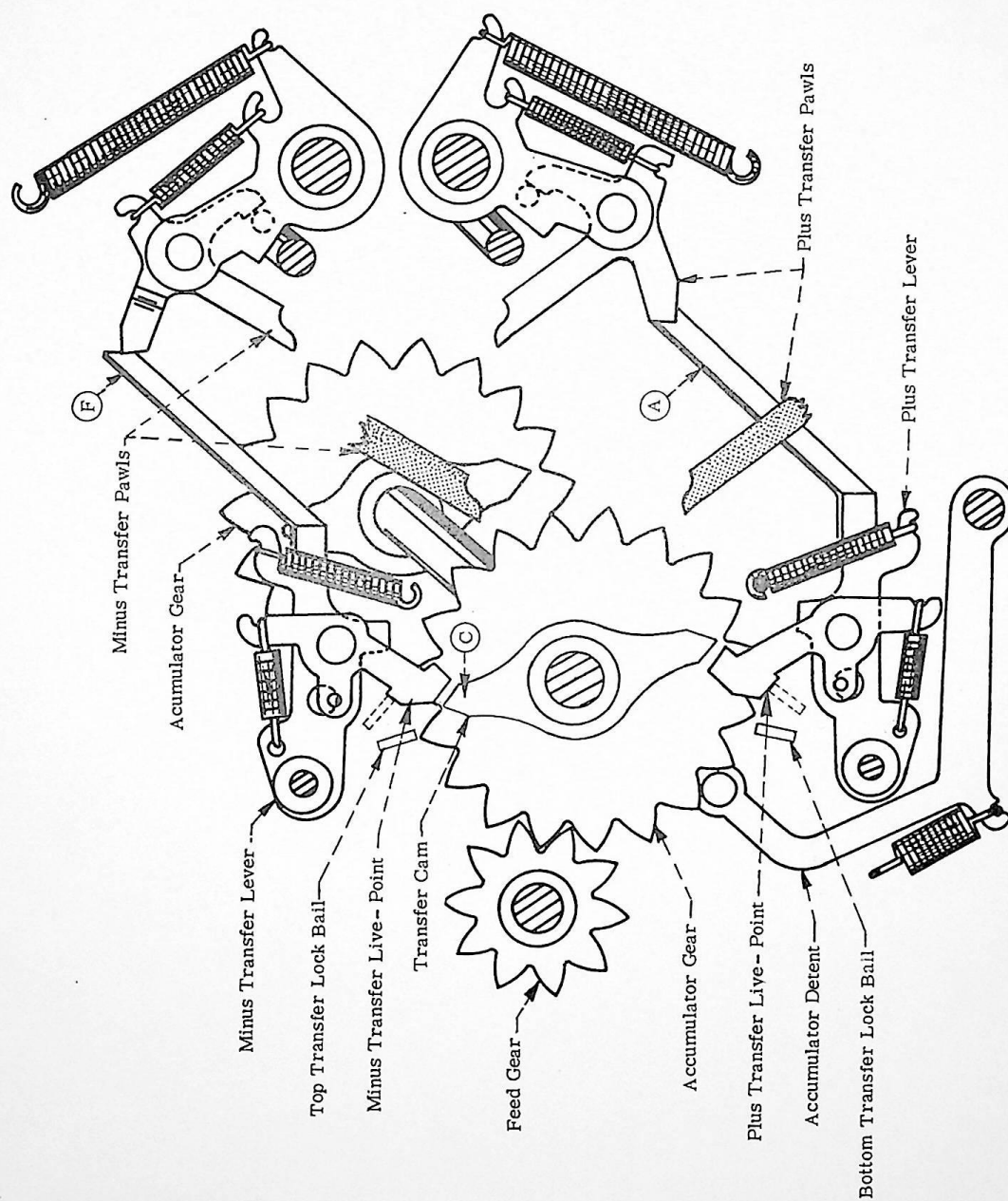
The position of the ear on the credit balance indicator determines whether a plus or a minus (credit balance) total is in the accumulator. When the condition of the accumulator changes from plus to minus or from minus to plus the fugitive one transfer action changes the position of the credit balance indicator to its plus or minus position depending upon which side of the accumulator the transfer took place in. In Sketch 9 the credit balance indicator is in its plus position, indicating

the amount in the accumulator is positive.

If a minus entry is made causing the amount in the accumulator to go negative a fugitive one transfer will occur on the minus side and the minus transfer pawl will be tripped in the first order. As the minus transfer pawl rocks in toward the gear it will contact ear R and rock the credit balance indicator into its minus position (shown dotted in Sketch 9). When the fugitive one transfer takes place on the plus side, the plus transfer pawl will strike ear R and rock the credit balance into its plus position.

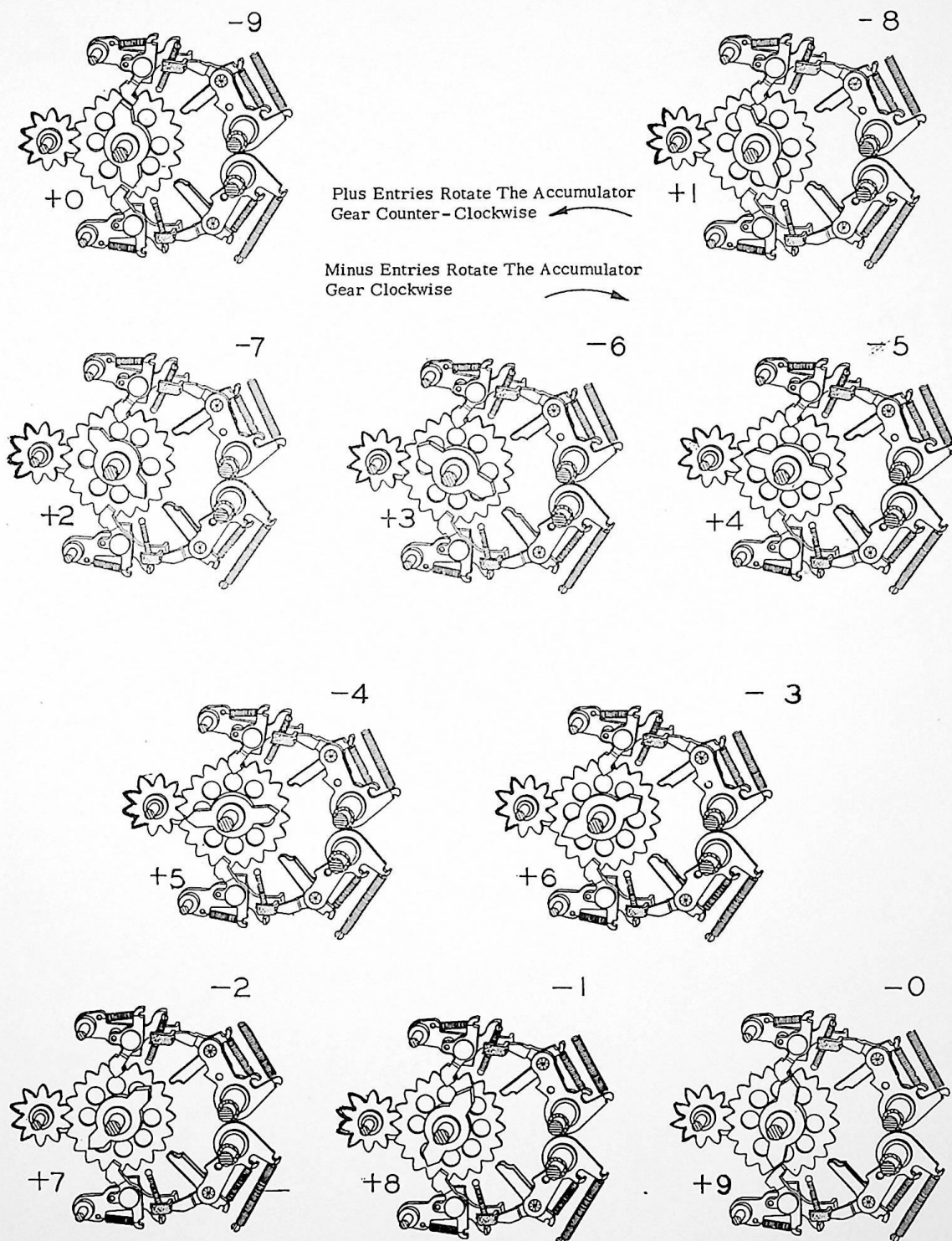
FRIDEN PRINTING CALCULATOR

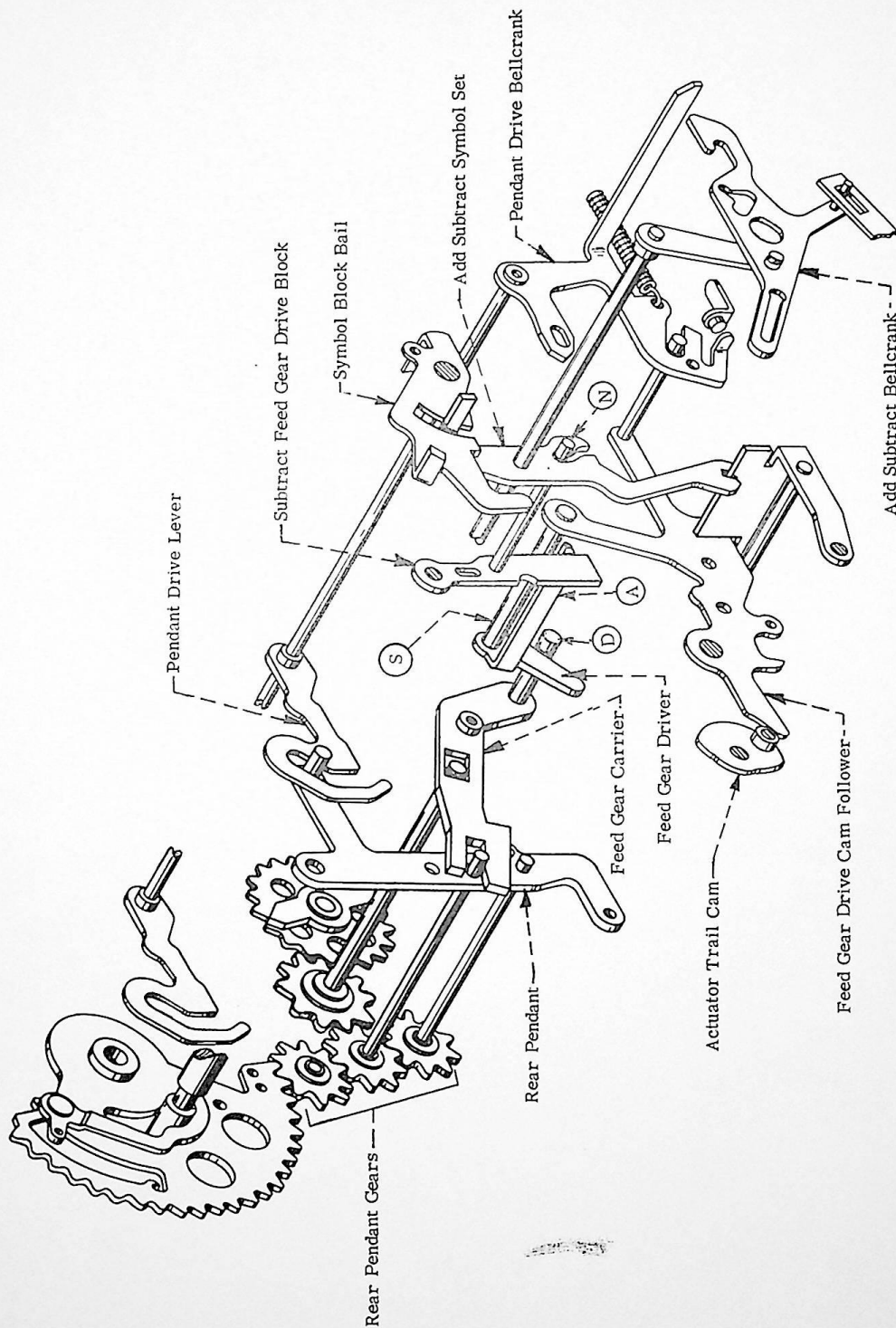
OPERATIONS - Accumulator



ACCUMULATOR

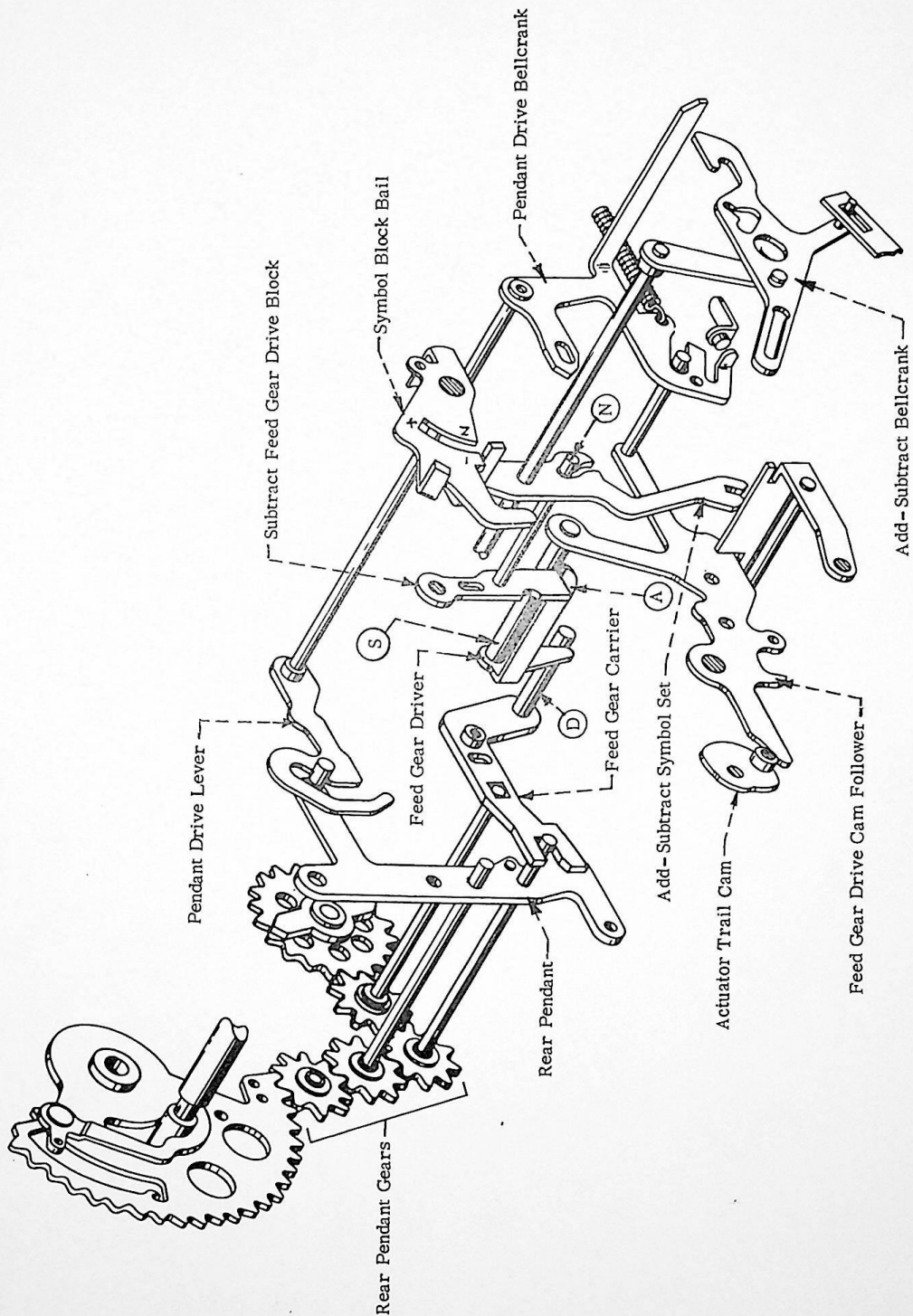
SKETCH 1

ACCUMULATORSKETCH 2

ACCUMULATORSKETCH 3

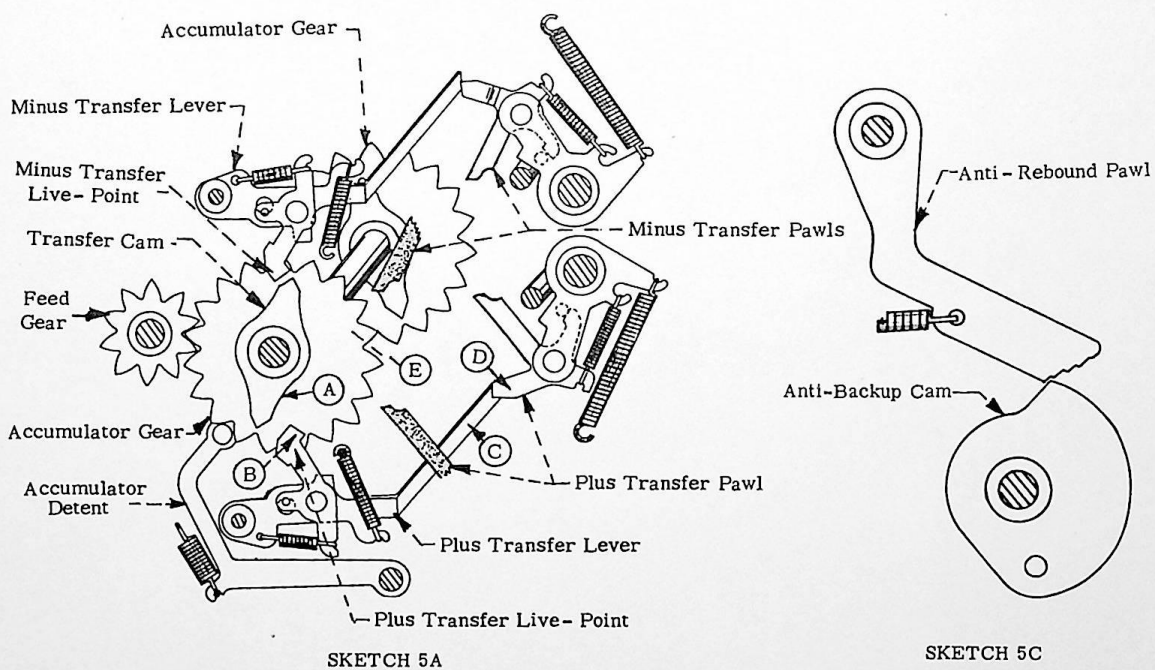
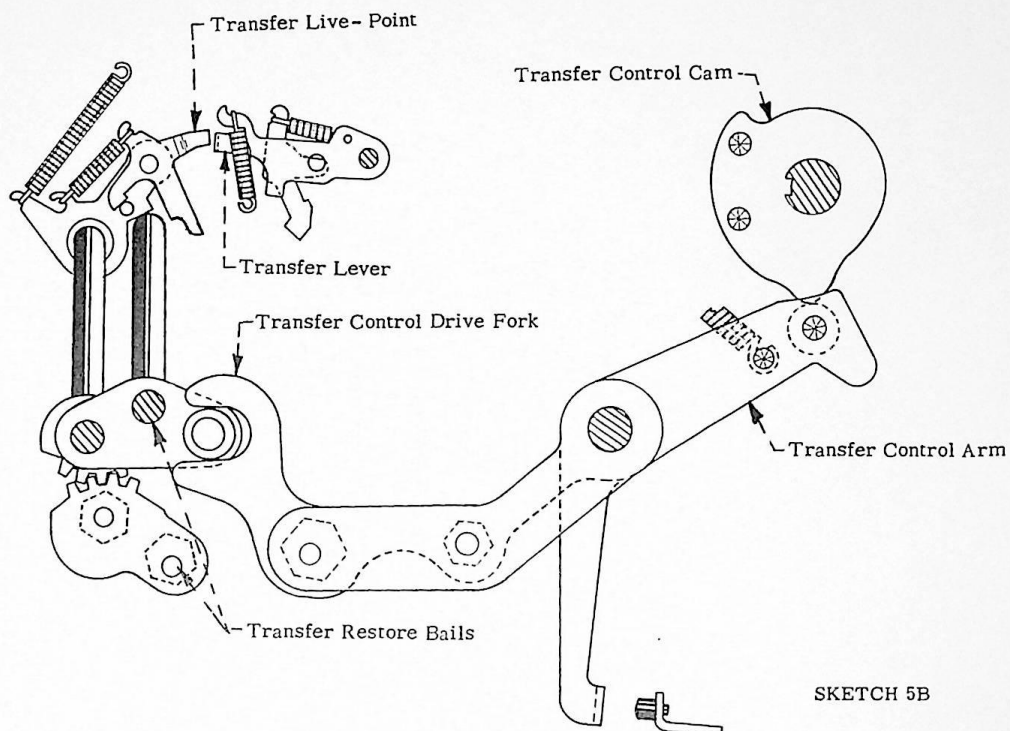
FRIDEN PRINTING CALCULATOR

OPERATIONS - Accumulator



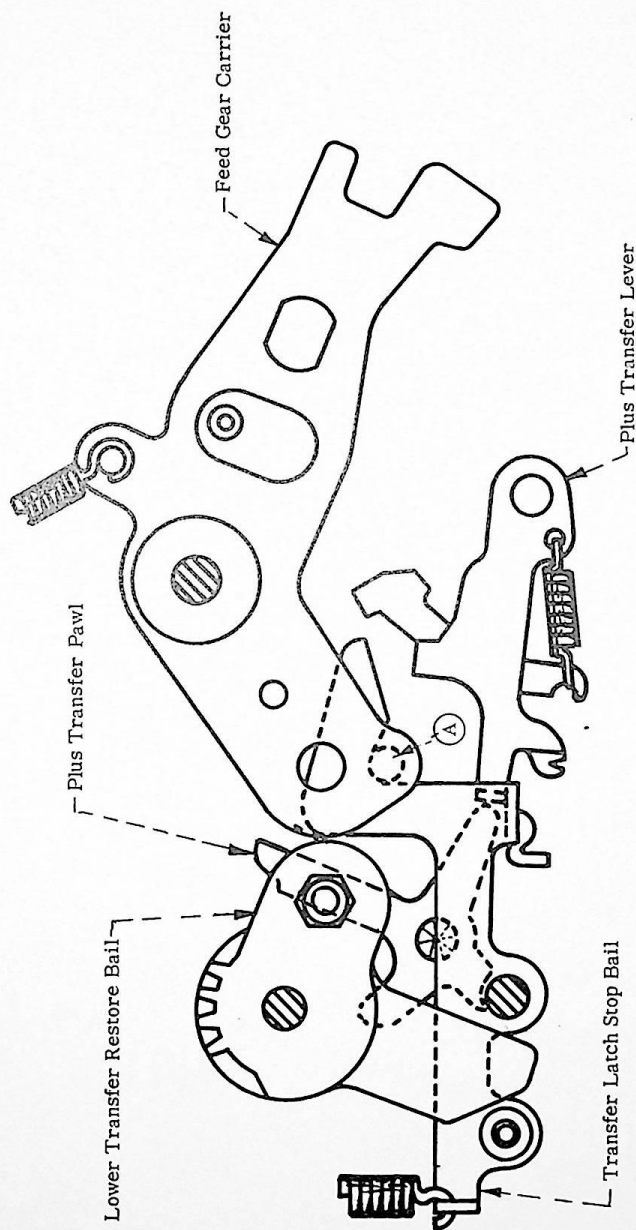
ACCUMULATOR

SKETCH 4



ACCUMULATOR

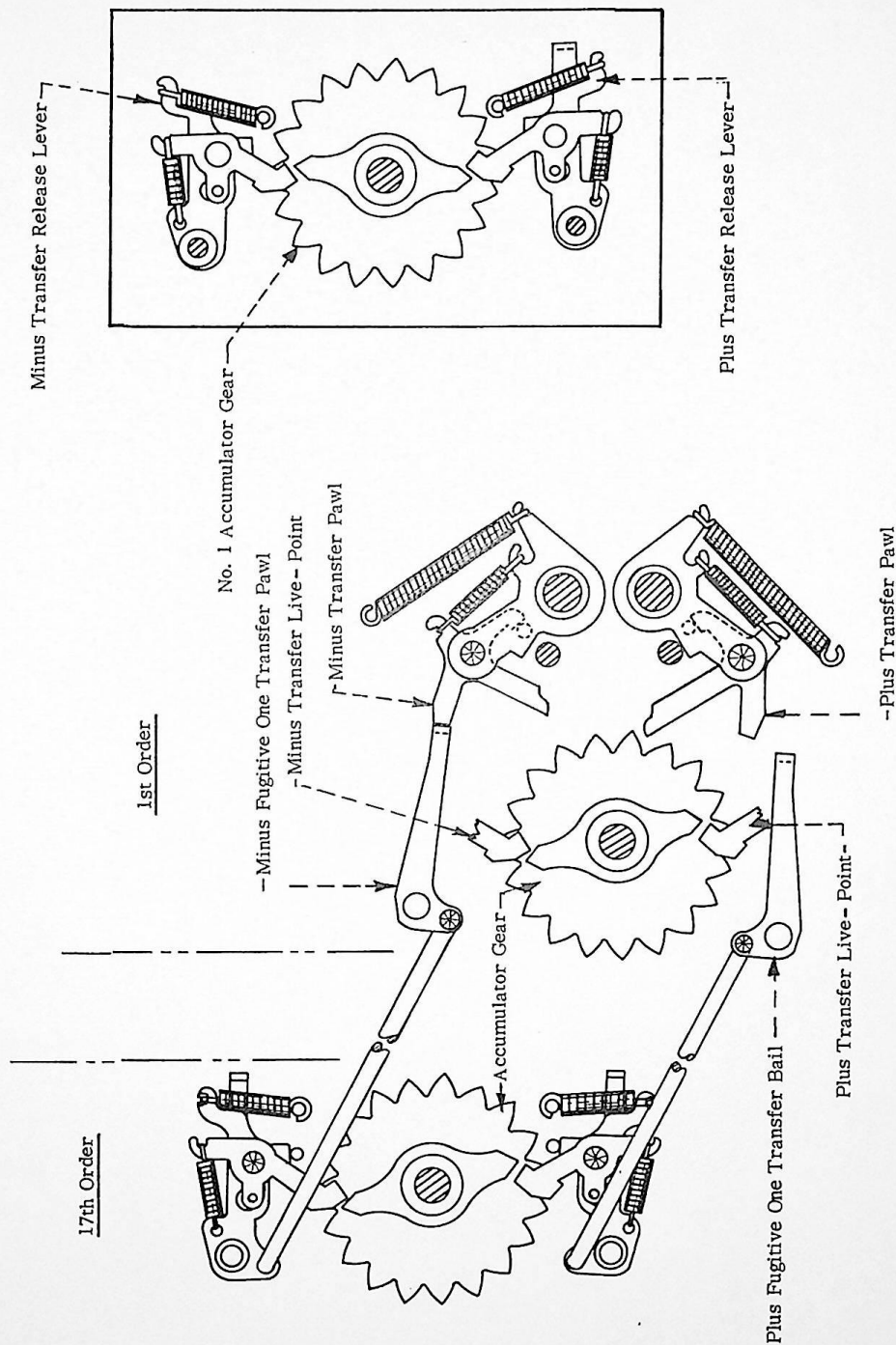
SKETCH 5



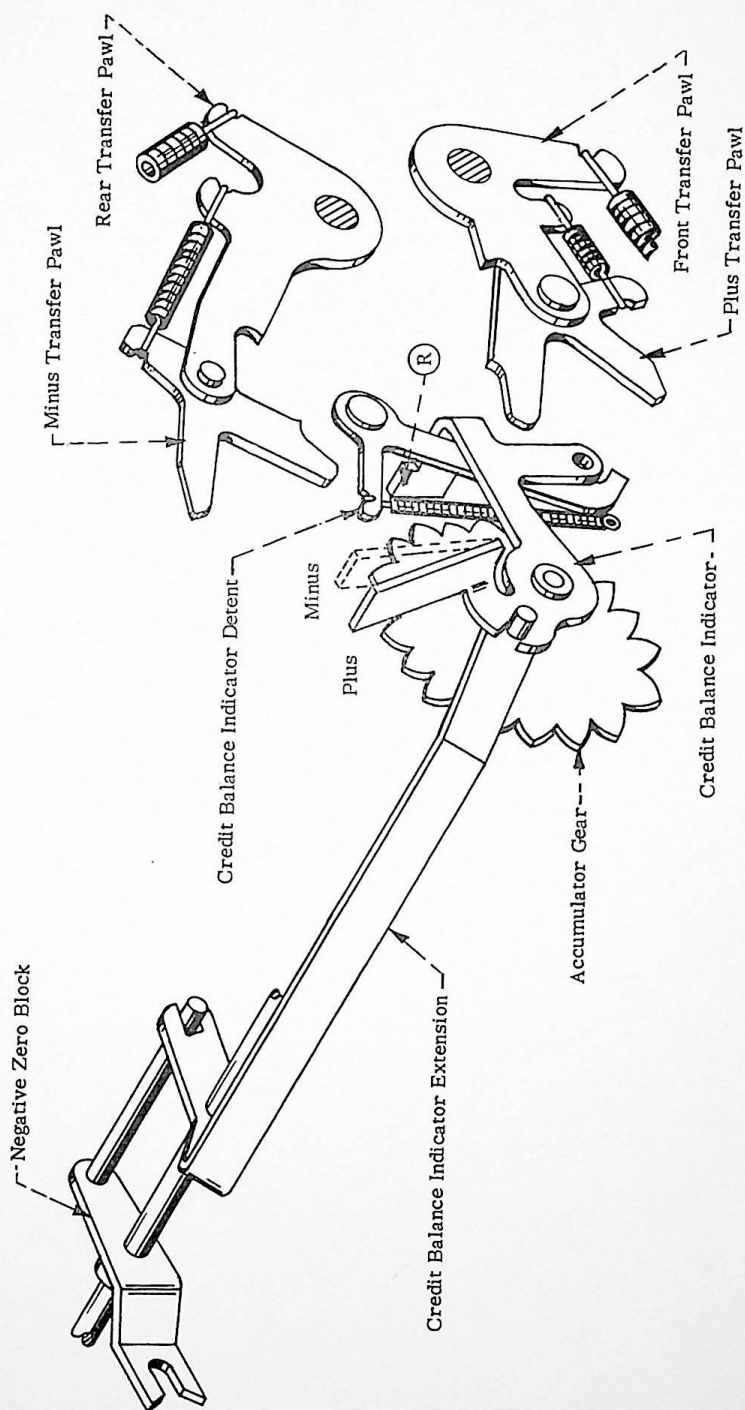
ACCUMULATOR
SKETCH 6

FRIDEN PRINTING CALCULATOR

OPERATIONS - Accumulator



ACCUMULATOR
SKETCH 7

ACCUMULATORSKETCH 8

TOTAL KEY - Sketch 1

Depression of the total key will cause the machine to read out the amount in the accumulator and print it on the tape with a total symbol at the right. Either a plus or a credit balance (minus) total may be read out depending on the position of the credit balance indicator.

Depression of the total key rocks the total bail counterclockwise (Sketch 1). This rotates the total rocker arm clockwise, pulling the link and the total extension link forward. Stud E is pulled forward by the total extension link, to rock surface X above stud H. The total overthrow block is also rocked up into a position where the hook can stop ear S of the total and sub-total control lever. Depression of the total key also starts the motor and causes the main clutch to be engaged as described in the MOTOR and DRIVE section. As the drive shaft begins to turn, roller A drops off the high of the cam, allowing the total and sub-total bellcrank to be spring urged clockwise. This pushes the total trip slide forward until stud H stops against surface W of the sub-total trip bail. Clockwise movement of the total and sub-total bellcrank against stud D rocks the total symbol control down, stud M rocks the total bellcrank clockwise to lift the selection control link out of engagement with the front pendant so the front pendant cannot be rocked into engagement with the check dial sectors.

The total and sub-total control lever is fastened to the same shaft as the total symbol control and rocks counterclockwise with it. Ear S stops against the hook of the total overthrow block to position the total and sub-total control lever so the cycle lock can enter the slot as shown in Sketch 1.

Counterclockwise movement of the total and sub-total control lever rocks the total symbol block and the minus total symbol block to condition the machine to print the proper total symbol.

The total symbol block also sets the total feed gear drive block rearward for a positive total, as shown in Sketch 1, or forward for a negative total.

SUB-TOTAL KEY - Sketch 2

Depression of the sub-total key will cause the machine to read out the amount in the accumulator, print it on the tape with a sub-total symbol at the right, and restore the amount back into the accumulator. The sub-total may be either plus or credit balance depending upon the position of the credit balance indicator.

Depression of the sub-total key rocks the sub-

total bail counter-clockwise. This, in turn, rotates the sub-total rocker arm and pulls the sub-total extension link forward. Forward movement of the link rocks the total and sub-total trip bails up out of the path of stud H. The total extension link is not pulled back so the total overthrow block is not rocked up.

As the drive shaft begins to turn, roller A drops off the high of the cam, allowing the total and sub-total bellcrank to be spring urged clockwise. This pushes the total trip slide forward until stud H stops against the bumper. Clockwise movement of the total and sub-total bellcrank against stud D rocks the total symbol control down, stud M rocks the total bellcrank clockwise to lift the selection control link out of engagement with the front pendant, so the front pendant cannot be rocked into engagement with the check dial sectors. The total and sub-total control lever is fastened to the same shaft as the total symbol control and rocks counterclockwise with it. During a sub-total operation the total and sub-total control lever is rocked twice as far as it is rocked during a total operation so the cycle lock will come up in front of the part as shown in Sketch 2.

Counterclockwise movement of the total and sub-total control lever sets the total symbol block to condition the machine to print the proper symbol.

The total symbol block also sets the subtract feed gear driven block rearward for a positive total, or forward for a minus total.

During a sub-total operation the rear pendant is rocked into engagement with the accumulator feed gears and the actuators make their downward stroke as described in the ACTUATOR section. However, in a sub-total operation the rear pendant must remain engaged with the accumulator feed gears during the upward stroke of the actuator also. When the total and sub-total control lever is rocked to its fully rearward position for a sub-total operation stud T rocks the rear pendant drive hook back away from stud U. Refer to ACTUATOR - Sketch 2. When stud U is not engaged by the rear pendant drive hook the sub-total cam follower is free to follow the sub-total cam. The contour of the sub-total cam is such that the rear pendant drive levers are not rocked up until after the upward stroke of the actuators. So the rear pendant will remain engaged with the accumulator feed gears and the sub-total restored on the upward stroke of the actuators.

TOTAL and SUB-TOTAL SYMBOLS - Sketch 3

The position of the credit balance indicator determines whether a plus or a minus total or sub-total

is to be taken; it also conditions the symbol mechanism so the correct symbol will be printed. The action of the credit balance indicator is explained in the ACCUMULATOR section.

During any total or sub-total operation the total and sub-total control lever is rocked counterclockwise to the position shown for a total, and twice as far for a sub-total.

As the total and sub-total control lever is rocked counterclockwise the minus total symbol block is rocked clockwise by stud B. Spring G holds the total symbol block against the minus total symbol block, so it also is rocked clockwise by the movement of the total and sub-total control lever. During a positive total operation the surface of the total symbol block indicated by the "T" in Sketch 3 is rocked under ear Q. For a positive sub-total the total and sub-total control lever is rocked twice as far, the total symbol block is also rocked twice as far placing the surface indicated by "S" under ear Q. For a minus total or sub-total the credit balance indicator is in its rearward position and blocks ear L so the total symbol block cannot rock clockwise under ear Q. The minus total symbol block is still free to rock. For a minus total the surface indicated by "T" will be under ear Q. For a minus sub-total, since the parts are rocked twice as far, the surface indicated by "S" will be under ear Q.

When the actuator symbol block bail is rocked down during the actuator downstroke ear Q will stop against one of the indicated surfaces. This will rock the actuator symbol block into position to stop the stud on the symbol actuator at the proper step.

To allow the actuator symbol block bail and the actuator symbol block to rock down to the total and sub-total positions ear V of the add-subtract symbol set must be in its plus position, under the long slot in the actuator symbol block bail. To accomplish this stud T cams the add-subtract bellcrank clockwise which rocks the add-subtract control lever and the add-subtract bellcrank the same distance for either a total or a sub-total operation even though the total and sub-total control lever is rocked twice as far for a sub-total operation.

TOTAL and SUB-TOTAL - Sketch 4

Any total or sub-total operation rocks the total control lever either to the total position as shown in Sketch 4, or twice as far to the sub-total position. Rotation of the total control lever rocks the transfer block lever down and pushes the transfer block interponent in front of stud K. As the rear pendant rocks in to mesh with the feed gear,

stud P pushes the transfer block interponent against stud K. This pushes the transfer block controller towards the rear of the machine. Rearward movement of the transfer block controller pulls the transfer lock bails in to lock the transfer live-points in place. When the transfer lock bails are blocking the live-points, the transfer levers cannot rock out and the live-points cannot yield. As the bottom transfer lock bail moves in it also causes shaft F to cam against the accumulator detents rocking them part way out of engagement with the accumulator gears.

When a total is read out, the accumulator gears are rotated by the down stroke of the actuators until they stop against the blocked live-points. The gears are rotated in the opposite direction from that in which entries are made. For plus totals the gears are rotated clockwise, for minus totals the gears are rotated counterclockwise. The position of the credit balance indicator, previously described determines whether a plus or a minus total is read out.

POSITIVE TOTAL - Sketch 5

When the credit balance indicator is in its forward position as shown in Sketch 5 a plus total will be read out. During any total or sub-total operation the total and sub-total symbol block is rocked down. If the credit balance indicator is in its forward (plus) position, ear C will clear ear J and the total and sub-total symbol block can rock down farther. As the total and sub-total symbol block rocks down stud R pushes the total feed gear drive block to the rear, over ear N of the feed gear driver. When ear N is blocked, the feed gear driver is forced against roller Y and cams the feed gear carrier counterclockwise as for a minus entry. This puts the feed gears in mesh with the lower row of gears on the rear pendant.

The down stroke of the actuators will drive the accumulator gears clockwise until they are stopped by the blocked transfer live-points (Sketch 4), at which point the actuator drive latches will yield as described in the ACTUATOR section. The down stroke of the actuators also sets the print wheels to print the total or the sub-total symbol as described previously.

CREDIT BALANCE TOTAL - Sketch 6

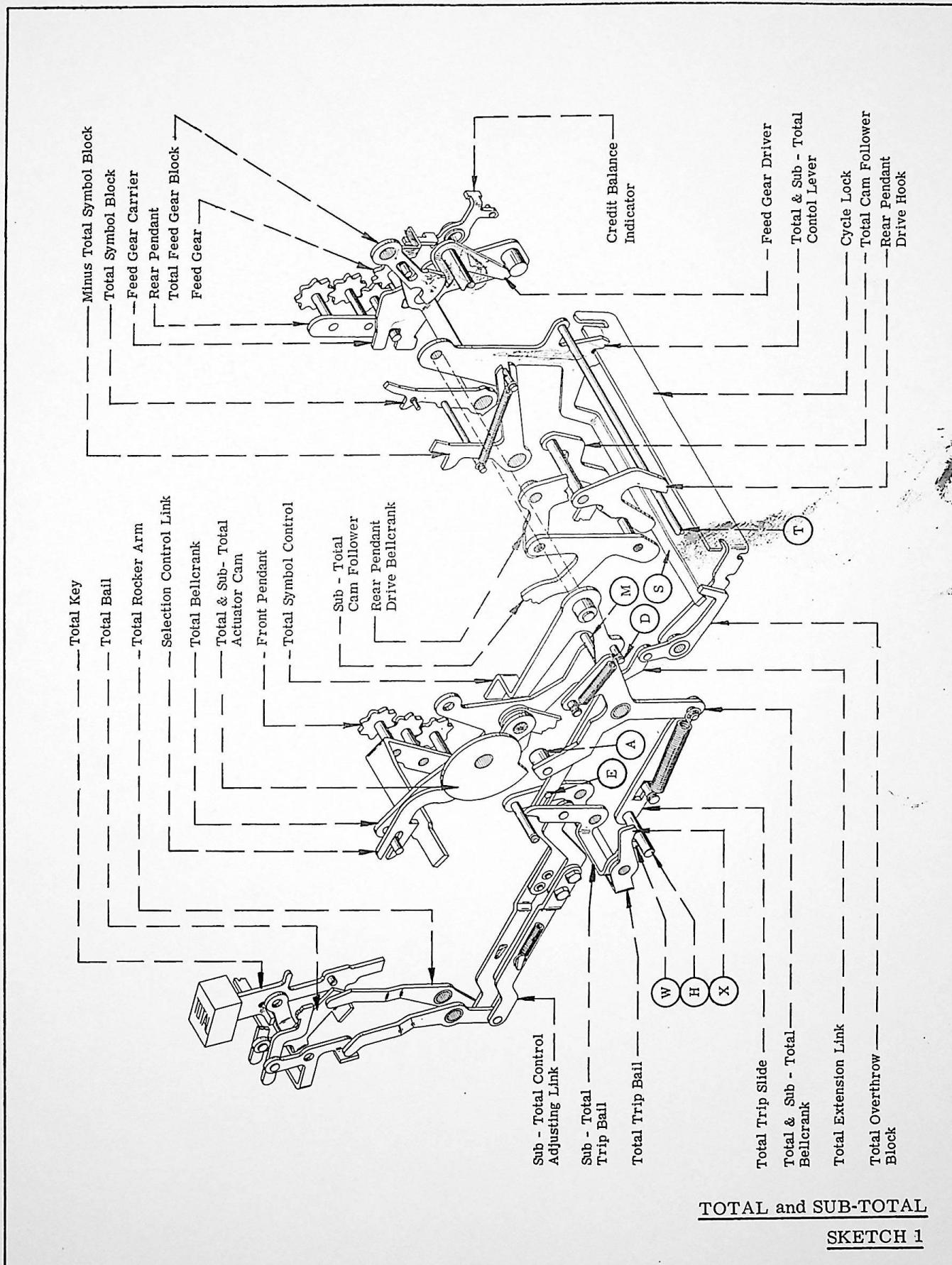
When the credit balance indicator is in its rearward position as shown in Sketch 6 a credit balance (minus) total is read out of the accumulator.

When ear J of the credit balance indicator is in its rearward (minus) position ear C is blocked and the total and sub-total symbol block cannot rock down. Stud R holds the total feed gear drive block

forward, away from ear N, so the feed gear driver cannot rock the feed gear carrier down. This leaves the feed gears in position to mesh with the middle row of rear pendant gears.

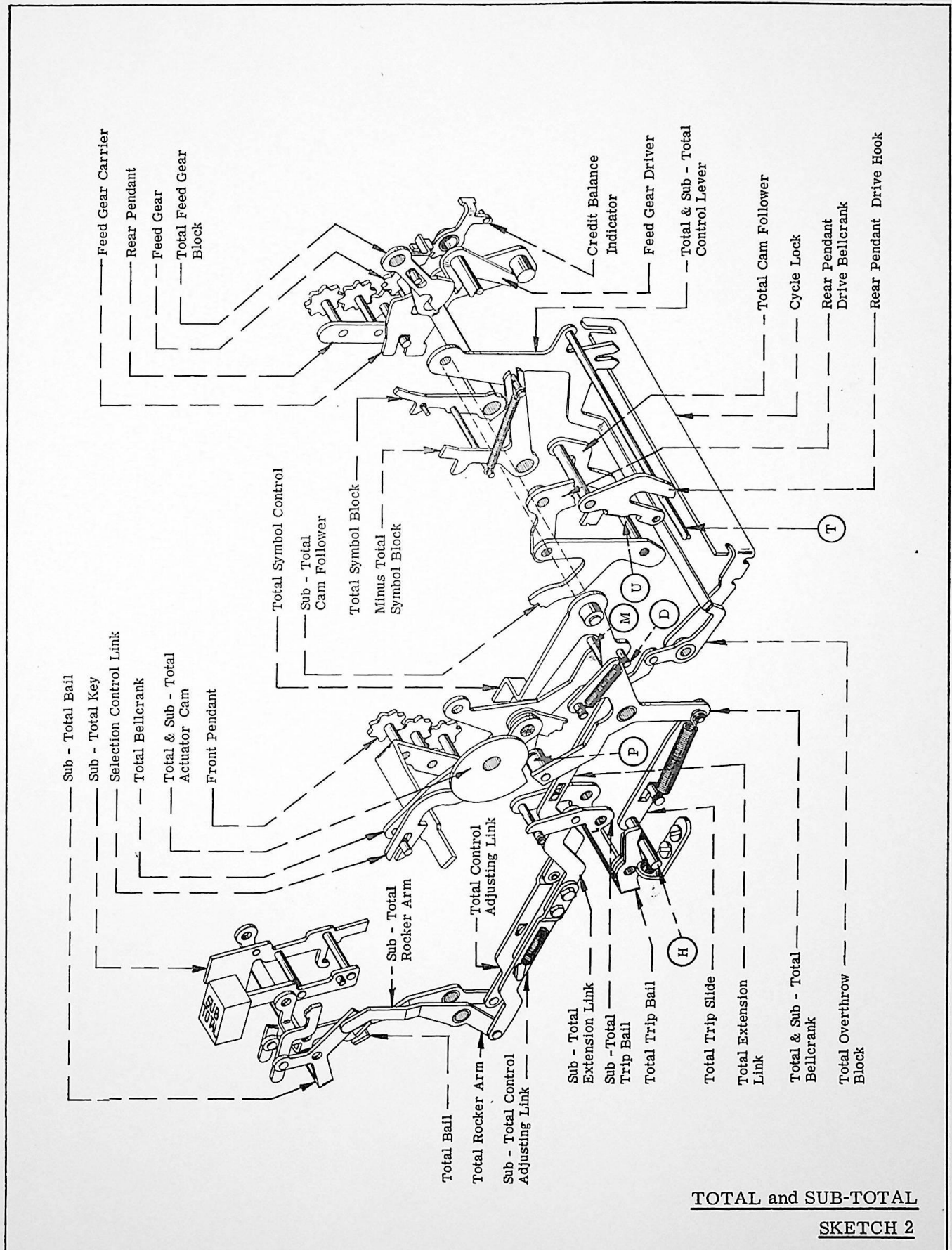
The downstroke of the actuators will drive the accumulator gears counterclockwise until they are

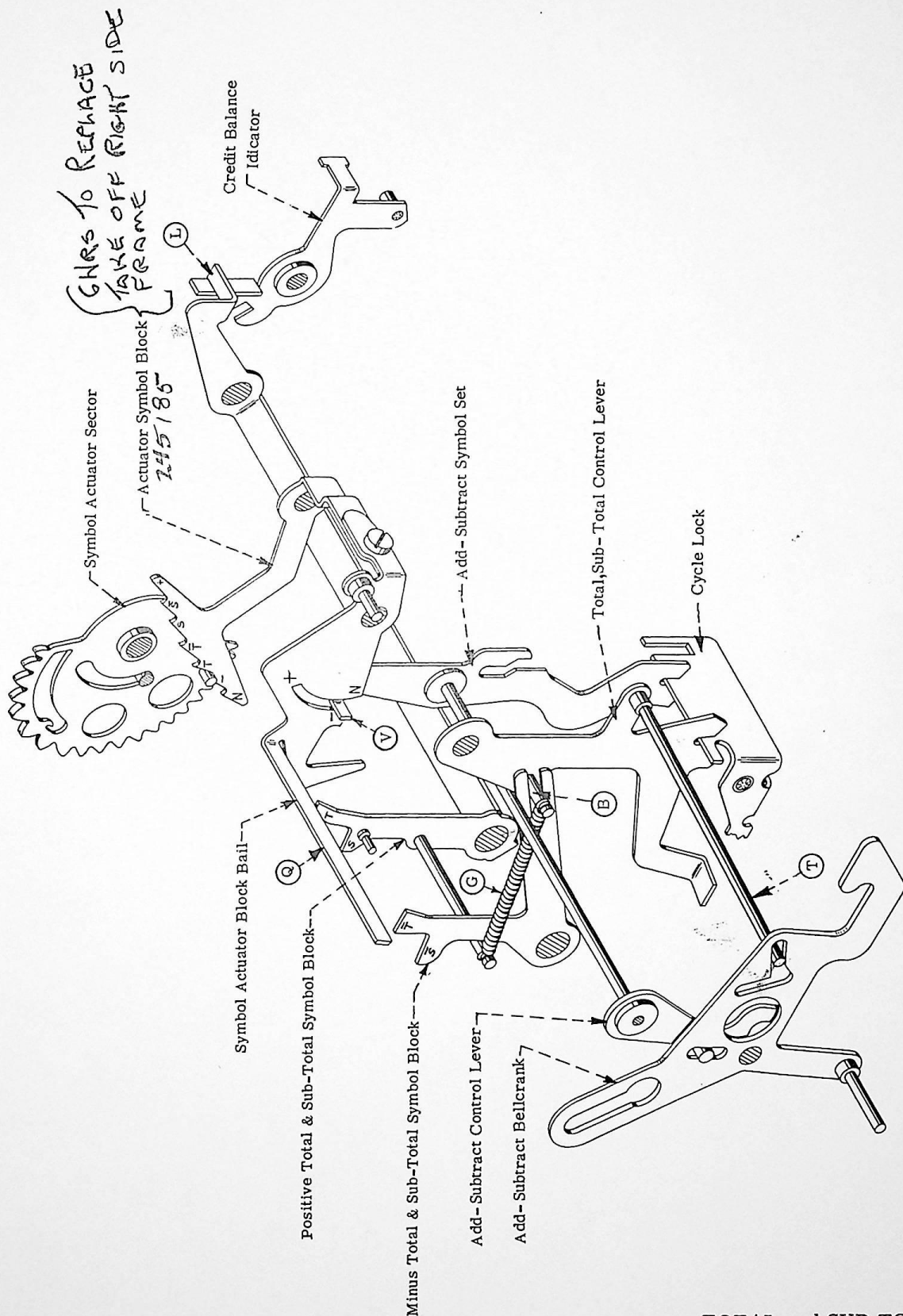
stopped by the blocked transfer live-points (Sketch 4), at which point the actuator drive latches will yield as described in the ACTUATOR section. The down stroke of the actuators also sets the print the total and the total symbol as described previously.



FRIDEN PRINTING CALCULATOR

OPERATIONS - Total and Sub-Total

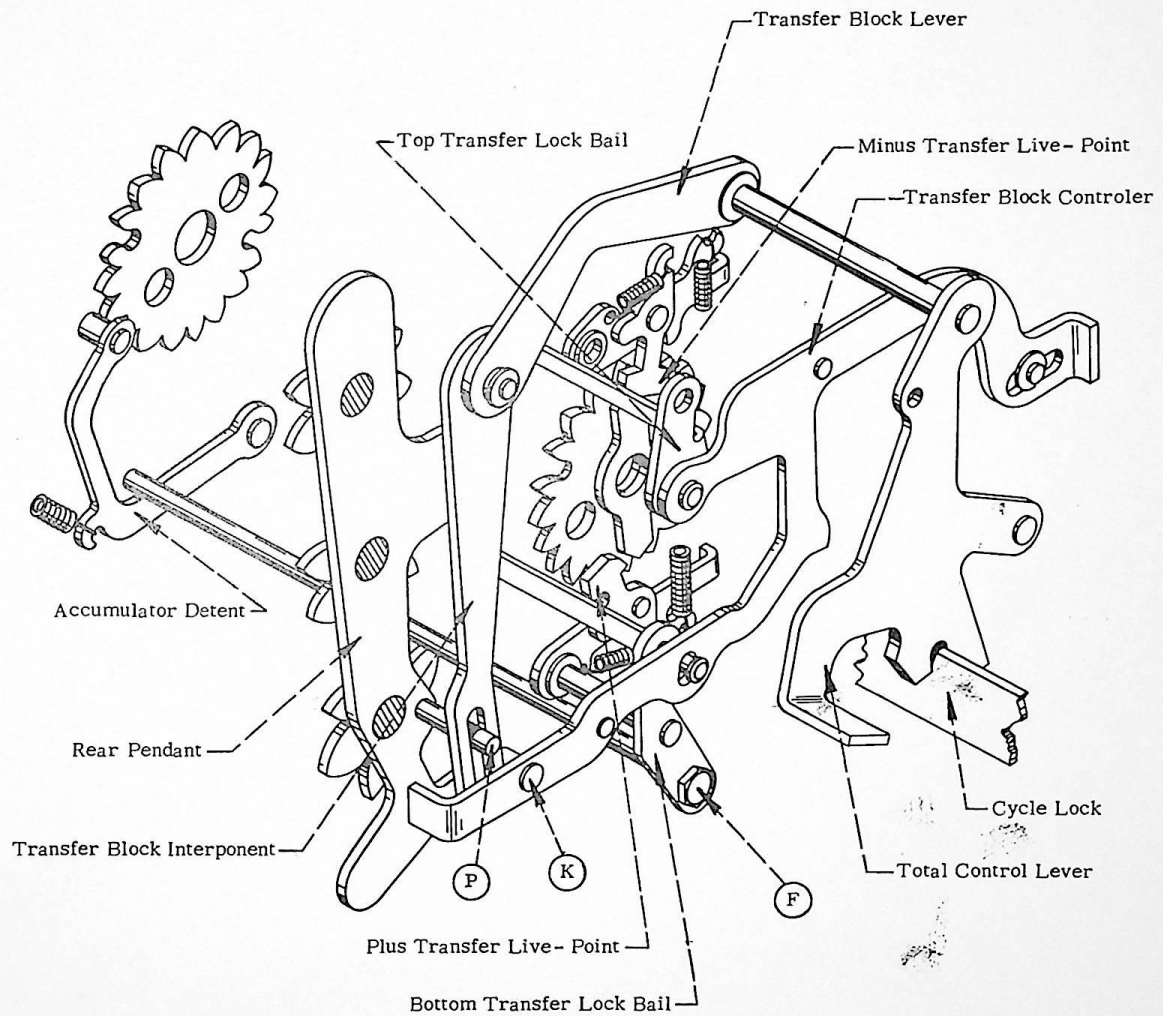




TOTAL and SUB-TOTAL

SKETCH 3

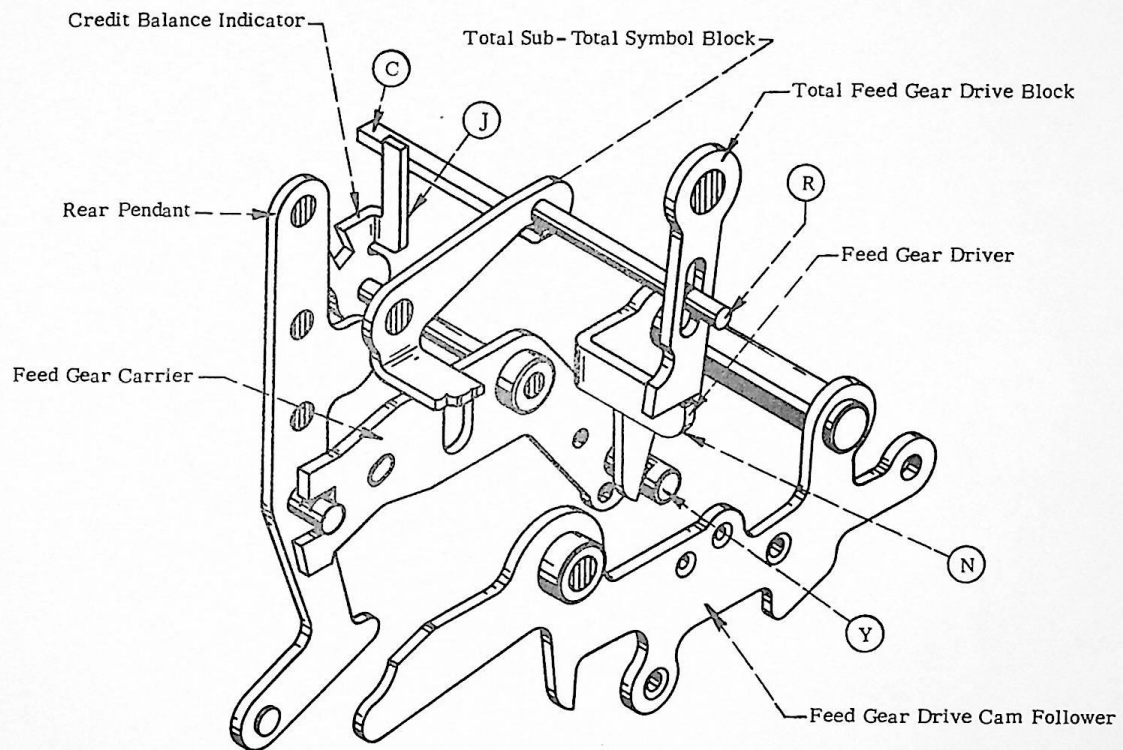
FRIDEN PRINTING CALCULATOR
OPERATIONS - Total and Sub-Total



TOTAL and SUB-TOTAL

SKETCH 4

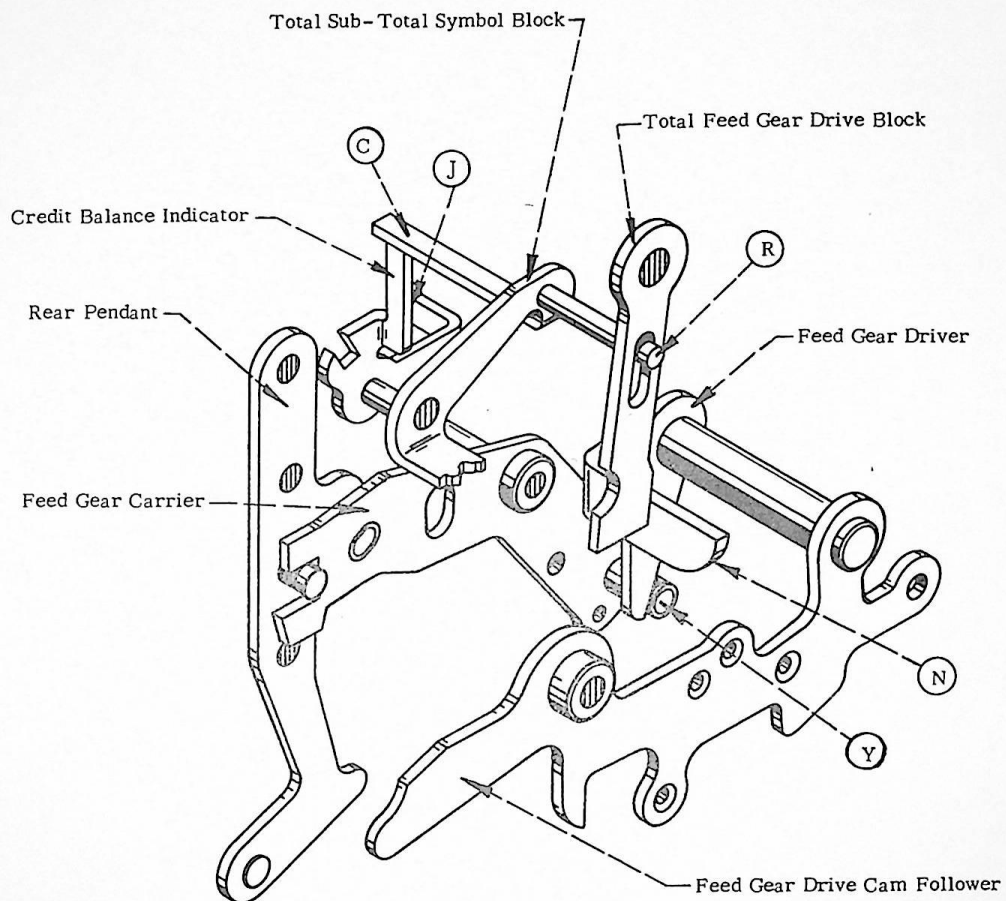
FRIDEN PRINTING CALCULATOR
OPERATIONS - Total and Sub-Total



TOTAL and SUB-TOTAL

SKETCH 5

FRIDEN PRINTING CALCULATOR
OPERATIONS - Total and Sub-Total



TOTAL and SUB-TOTAL

SKETCH 6

SETTING PRINT WHEEL - Sketch 1

The upper row of gears on the front pendant is always in mesh with the actuators and also with the zero foil drum gear as shown in Sketch 1. As the actuators are rocked down, the print wheels are rotated an amount proportional to the actuator movement. For example, if there was a selection of "5", the actuator would rock down five teeth in that order before the drive latch yielded, and the print wheel would be rotated to a "5".

ALIGNERS - Sketch 2

After the downward stroke of the actuators is completed and the figures are in the print wheels the pendant gear aligner bail and the print wheel aligners must be set to hold the figures during printing.

As the cam follower drops to the low of the transfer control cam as shown in Sketch 2 the front pendant gear aligner bail is spring urged into a tooth space in the upper row of front pendant gears as shown. Rocking of the front pendant gear aligner bail moves the print wheel aligner release shaft away from the print wheel aligners. This allows the print wheel aligners to be spring urged into the print wheel detents on the print wheels.

Clockwise movement of the front pendant gear aligner bail into the gears rocks the hook away from ear K of the left print control arm. If the bail is blocked, by hitting a tooth instead of a tooth space for example, the hook will hold ear K so the print control arm and the print control shaft cannot rock down to release the print arms to print.

The front pendant gear aligner bail is restored by stud Z on the left actuator lead cam striking surface G and driving the cam follower forward rocking the bail out of engagement with the gears.

ZERO FOILS - Sketch 3

The zero foils prevent the printing of non-significant zeros to the left of the first figure selected. Each print arm assembly has a zero foil associated with it except the first two numeral wheels and the symbol print wheels which operate independently of the numeral print wheels. The first two numeral wheels will always print, even if there is no selection, in which case they print ".00".

The zero block drum gear in each order has a zero block drum attached to it as shown in Sketch

3. Each zero block drum has a notch corresponding to the zero position of the print wheel. When the print wheel is in its zero position the nose of the zero foil can enter the notch and lip A can rock in to hold the print arm in its home position. If the print wheel is not in its zero position the nose of the zero foil cannot enter the notch but will ride on the outside of the drum, lip A cannot engage the print arm so the print wheel in that order can print.

Each zero foil has an ear B which overlaps the zero foil in the order to the left. When one zero foil is held out because the drum is out of its zero position all the zero foils to the right will also be held out even though there are zeros in those orders.

Just before printing takes place the cam follower drops to the low of the zero block cam as shown in Sketch 3. This allows the print blocking control arm and the shaft to rock clockwise away from the zero foils. The zero foils are then urged by spring C in toward the zero block drum. If the nose enters the notch lip A will engage the print arm and printing will be blocked in that order. If the nose comes to rest against the drum lip A cannot engage the print arm and printing will take place in that order and all orders to the right.

PRINTING - Sketch 4

After the print wheels have been set and the aligners are in place, further rotation of the drive shaft will allow roller W (Sketch 4) to drop into the notch in the print control cam. This causes the print control bellcrank to rock counter-clockwise, away from stud D. This allows the print control arm and the print control shaft to rock counter-clockwise. This leaves any print wheels which are not held by the zero foils free to be driven against the platen by spring N.

RIBBON COLOR CONTROL - Sketch 5

All plus entries and totals are printed in black and minus entries and credit balance totals are printed in red.

The color is determined by the red-black print control which is fastened to the right ribbon control arm. If the upward movement of the red-black print control is stopped the print will be black, if it can raise all the way the print will be red.

As the left rocker gear sector rocks counter-clockwise (in Sketch 5A) surface Y rocks forward allowing roller A to drop. This allows the left

ribbon control arm, urged by spring S, to rock clockwise. The right and left ribbon control arms which are fastened to the same shaft rock to raise the left and right ribbon guides to position the ribbon between the print wheels and the platen for printing.

For plus operations the red-black print control is positioned by the add-subtract bellcrank (Sketch 2A) so ear P, as it rises, will strike form C of the total symbol control lever. This limits the upward movement of the ribbon and the print will be black.

During minus operations the add-subtract bellcrank rocks the red-black print control further so ear P will be clear of form C. This will permit the ribbon guides to rise all the way and the print will be red. During total and sub-total operations the color is controlled by stud E on the total and sub-total symbol block, the operation of which will be explained later. When there is a plus total or sub-total stud E is in the position shown in Sketch 5C and limits the upward movement of ear M of the red-black print so the print will be black.

For a credit balance (minus) total or sub-total stud E is rocked back, away from ear M so the ribbon can rise all the way and the print will be red.

LEFT RIBBON FEED MECHANISM - Sketch 6

The same cams that drive the actuators in their downward and upward stroke also drive the ribbon feed mechanism. In Sketch 6A as the check dial restore assembly rocks, moving the actuating link rearward, the stud on the ribbon drive arm will also move rearward. The stud, in Sketch 6B, is shown in the lower notch of the ribbon reverse link indicating the machine is feeding the ribbon to the left. If the stud was in the upper notch, the machine would be feeding the ribbon to the right. As the stud on the ribbon drive arm pushes the ribbon reverse link rearward, the left and right feed drive bellcranks are rotated counter-clockwise, causing the following to take place in sequence.

1. Lip A disables the right holding pawl.
2. The right feed pawl contacts Lip B and is held away from the right ratchet.
3. The left feed pawl contacts and rotates the left ratchet two teeth counter-clockwise. This unrolls the ribbon from the right spool and rolls it on the left spool.
4. The left holding pawl prevents the spool from backing up.
5. As the actuator trail cam causes the upward stroke of the actuators, the ribbon feed mechanism restores.

REVERSING THE RIBBON FEED FROM LEFT TO RIGHT

When the ribbon has been completely unwound from the right spool, the left feed pawl will engage and try to move the ratchet gear, but the tension on the ribbon, which is fastened to the right spool, will not allow the ratchet gear to turn, this prevents the left feed drive bellcrank and the ribbon reverse link from moving. Since the ribbon drive arm is still being moved by the cam follower, the spring on the ribbon reverse link yields and the stud slides into the forward notch.

RIGHT RIBBON FEED MECHANISM - Sketch 7

With the ribbon drive arm stud in the upper notch of the ribbon reverse link the ribbon will be shifted to the right after each printing operation. During the downward stroke of the actuators, the ribbon reverse link is moved rearward rocking the right feed drive bellcrank counter-clockwise. The right feed pawl moves two teeth rearward on the right ratchet. The left feed pawl is held disabled by Lip D. As the stud on the ribbon drive arm moves forward during the upward stroke of the actuators, the ribbon reverse link is moved forward, rocking the left feed drive bellcrank clockwise which rocks the right feed drive bellcrank through the right feed drive link, causing the following to take place in sequence:

1. Lip T disables the left holding pawl.
2. The left feed pawl, blocked by Lip D, moves away from the left ratchet.
3. The right feed pawl contacts and rotates the right ratchet two teeth clockwise. This unrolls the ribbon from the left spool and rolls it on the right spool.
4. The right holding pawl prevents the spool from backing up.

REVERSING THE RIBBON FEED FROM RIGHT TO LEFT

When the ribbon has been completely unwound from the left spool, during the upward stroke of the actuators as the stud tries to move the ribbon reverse link forward, the tension of the ribbon on the right ratchet will stop the linkage from moving. The ribbon drive arm stud will be cammed from the upper notch in the ribbon reverse link to the lower notch as the ribbon drive arm is moved forward by the actuator cam follower.

PLATEN CENTRALIZING - Sketch 8

When a tape has been quickly pulled up and torn off, it is possible for the platen to stop so that a tooth of the detent gear is directly over the detent;

therefore, it is necessary to have a centralizing action occur before printing. As the paper feed cam rotates, the paper feed cam follower roller will drop off of point A on to section 1 causing the paper feed cam follower to rock counter-clockwise and raise the feed pawl link rocking the feed pawl rearward to pick up a tooth of the ratchet gear. As the paper feed cam continues to rotate Section 2 of the cam will cause the feed pawl link to be pulled downward and the feed pawl actuated forward to rotate the platen to a centralized position.

TAPE FEED AFTER PRINTING - Sketch 9

SINGLE SPACE FEED: When the space control lever is positioned rearward, Lip 1 of the space control arm will limit the travel of the feed pawl link stud to single space. As the paper feed cam rotates the centralizing action previously described, Sketch 7, will occur. As the ribbon control arms rock up to raise the ribbon guides the paper feed block arm is rocked forward clear of stud G. After the centralizing action, the roller will drop to Section 3 of the cam causing the paper feed cam follower to rock counter-clockwise raising the feed pawl link until its stud contacts Lip 1 of the double space control bail. At the same time, the feed pawl will be rocked rearward, to be in position to pick up one tooth of the ratchet gear.

As the paper feed cam continues to rotate, the paper feed cam follower roller will contact Section 4 of the paper feed cam, causing the paper feed cam follower to pull the feed link downward, which, in turn, will rock the feed pawl forward and rotate the platen one space.

DOUBLE SPACE FEED: When the space control lever is positioned forward, the same action will occur as with the Single Space, except the stud of the feed pawl link will strike Lip 2 of the double space control bail. The feed pawl will be rocked farther and pick up two teeth of the ratchet gear.

DOUBLE SPACE AFTER A TOTAL OR SUB-TOTAL: The depression of either the total or sub-total keys will rock the total bellcrank and stud V will raise the double space control bail. Should the space control arm be in single space position, the double space control bail will pivot the space control arm to double space position. The same action will occur as described under Double Space Feed.

NON FEED: During keyboard clear operations and the counting cycles of multiplication and division the left ribbon control arm is blocked and the shaft cannot rotate so the paper feed block arm does not rock away from stud G and the paper feed link cannot raise to operate the feed pawl.

MULTIPLICATION AND DIVISION SYMBOLS - Sketch 10

There are two symbol print wheels in the printing calculator. The first, at the extreme right, contains the multiply (X), equals (=), Negative equals ($\bar{=}$), and the division ($\div$) symbols and is operated by those keys.

The print wheel is positioned for printing the proper symbol by the symbol idler sector (Sketch 10) which, in turn, is positioned by the symbol control shaft and the symbol drive sector. The symbol drive sector is positioned by ear R of the symbol sector stop. The operation of the symbol sector stop is explained in the MULTIPLICATION, DIVISION, and MEMORY UNIT sections. When the check dial restore assembly rocks up to clear the check dial during the downstroke of the actuators stud J rocks back allowing the spring to pull one of the steps on the symbol drive sector up against ear R. This rotates the symbol control shaft and the symbol idler sector to position the print wheel to print the correct symbol. Depression of the division key positions ear R to stop the second step of the symbol drive sector to position the print wheel for a division ($\div$) symbol. Depression of the equals, transfer equals, or accumulative equals positions ear R to stop the third step and the print wheel to be set for an equals symbol. The negative equals key rocks ear R clear of the symbol drive sector allowing it to follow stud J all the way and the print wheel to be set for a negative equals ($\bar{=}$) symbol. The top step of the symbol drive bellcrank is the home position of ear R. When ear R is on the top step of the symbol drive sector the print wheel is positioned to print a times (X) symbol. The "X" symbol is printed for "X", "X²", to memory, and from memory, and after a transfer key operation.

The symbol drive sector and the print wheel are restored on the upward stroke of the actuators when stud J rocks forward. This also restores the print wheel to its home position. The symbol sector stop is not restored until later in the operation.

Stud H normally blocks the shelf (shown dotted in Sketch 10) on the symbol block bellcrank so the character print arm cannot rock down when the print control shaft (Sketch 4) drops down to allow the print wheels to print. During multiplication, division, and memory key operations the print control arm (Sketch 10) is rocked up or down as explained in the sections relating to those operations. This rocks stud H away from the shelf on the symbol block leaving the character print arm assembly free to print.

The symbol block drum is fastened to the symbol

idler sector and operates in conjunction with the print block sensing finger to prevent the second symbol print wheel printing when an equals or negative equals symbol is being printed. The times (X) and the divide symbols are always printed with another symbol on the second print wheel. The print block sensing finger is operated by the same shaft that operates the zero foils (Sketch 3).

PLUS, MINUS AND NON-ADD SYMBOLS - Sketch 11

The second symbol print wheel contains the plus (+), minus (-), non-add (N), total (T, $\bar{t}$), and sub-total ($\bar{S}$) symbols.

When the add key is depressed the add-subtract bellcrank is rocked clockwise. This, in turn, rocks the add-subtract control lever and the add-subtract symbol set counter-clockwise, moving ear A under the slot in the actuator symbol block bail. Depression of the subtract key moves the add-subtract bellcrank twice as far, placing ear A under the surface of the add-subtract symbol set marked (-) in Sketch 11. Depression of the non-add key does not move the add-subtract bellcrank so ear A remains in its home position, under the surface of the add-subtract symbol set marked (N) in Sketch 11.

As the right rocker gear is rocked counter-clockwise during the downward stroke of the actuators the spring pulls stud Z, rocking the actuator symbol block bail down against ear A. This, in position the appropriate step to stop stud D on the symbol actuator sector.

The symbol actuator sector is always spring urged counter-clockwise. When the actuator drive shaft rocks down it rotates until stud D stops against one of the steps on the actuator symbol block. Movement of the symbol actuator sector rotates the upper gear of the front pendant which in turn rotates the idler gear to set the symbol print wheel.

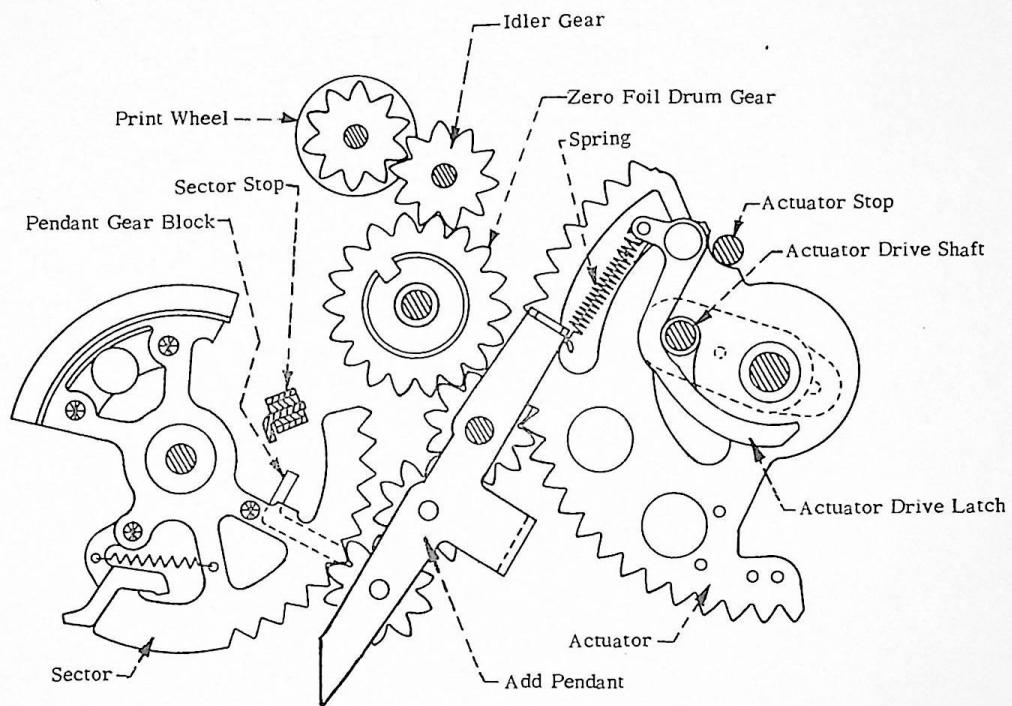
The upward movement of the actuator drive shaft restores the symbol actuator sector.

PRINT BLOCKING - Sketch 12

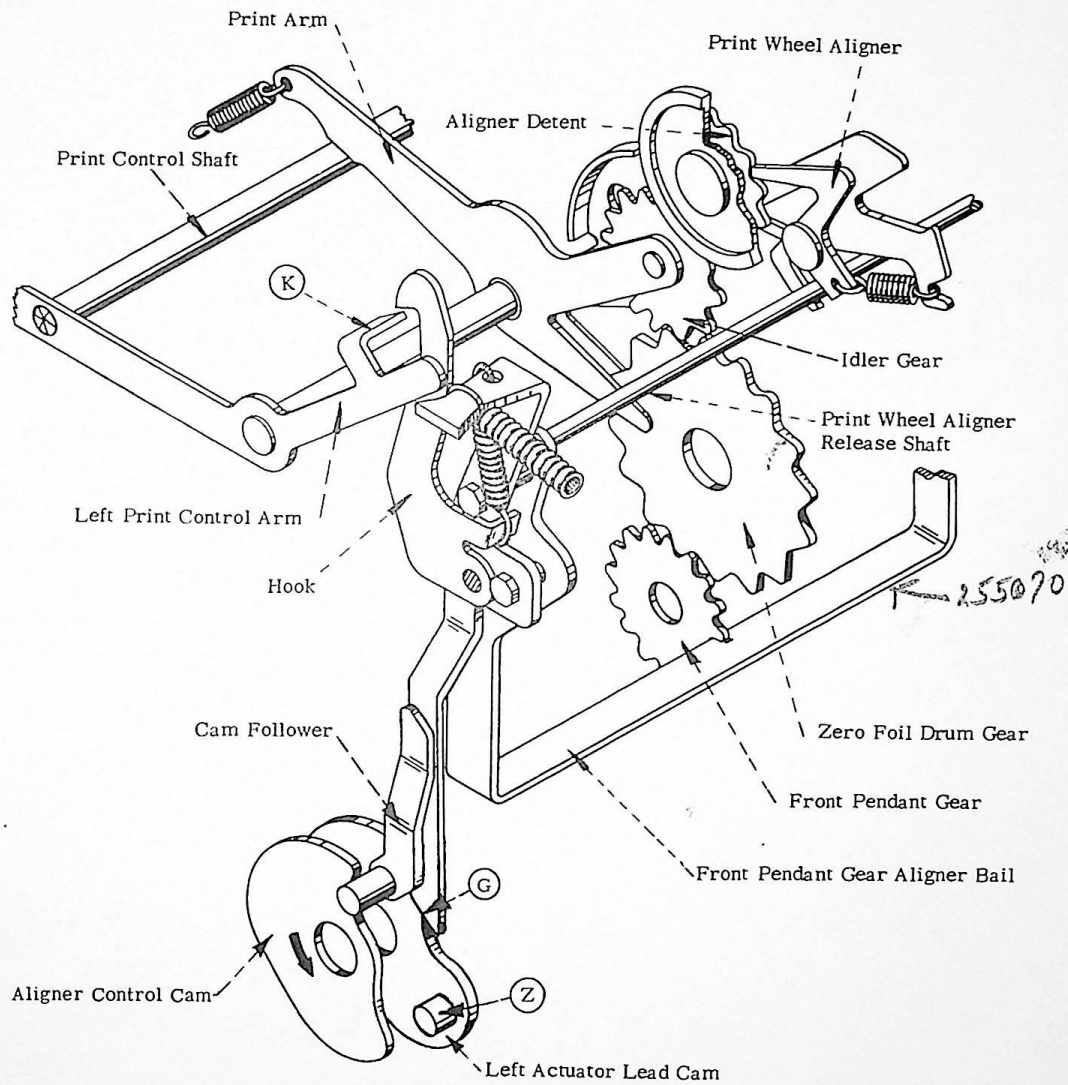
During keyboard clear, backspace operations and during the counting cycles of the multiplication and division operations printing must be blocked.

During keyboard clear and backspace operations the print block hook is rocked up behind ear G (see SELECTION - Sketch 3). This prevents the left ribbon control assembly rocking clockwise (Sketch 13). Ear G remains under the end of the print control shaft so it cannot rock down and the paper feed block arm remains over stud A so the paper feed cam follower cannot operate to advance the tape.

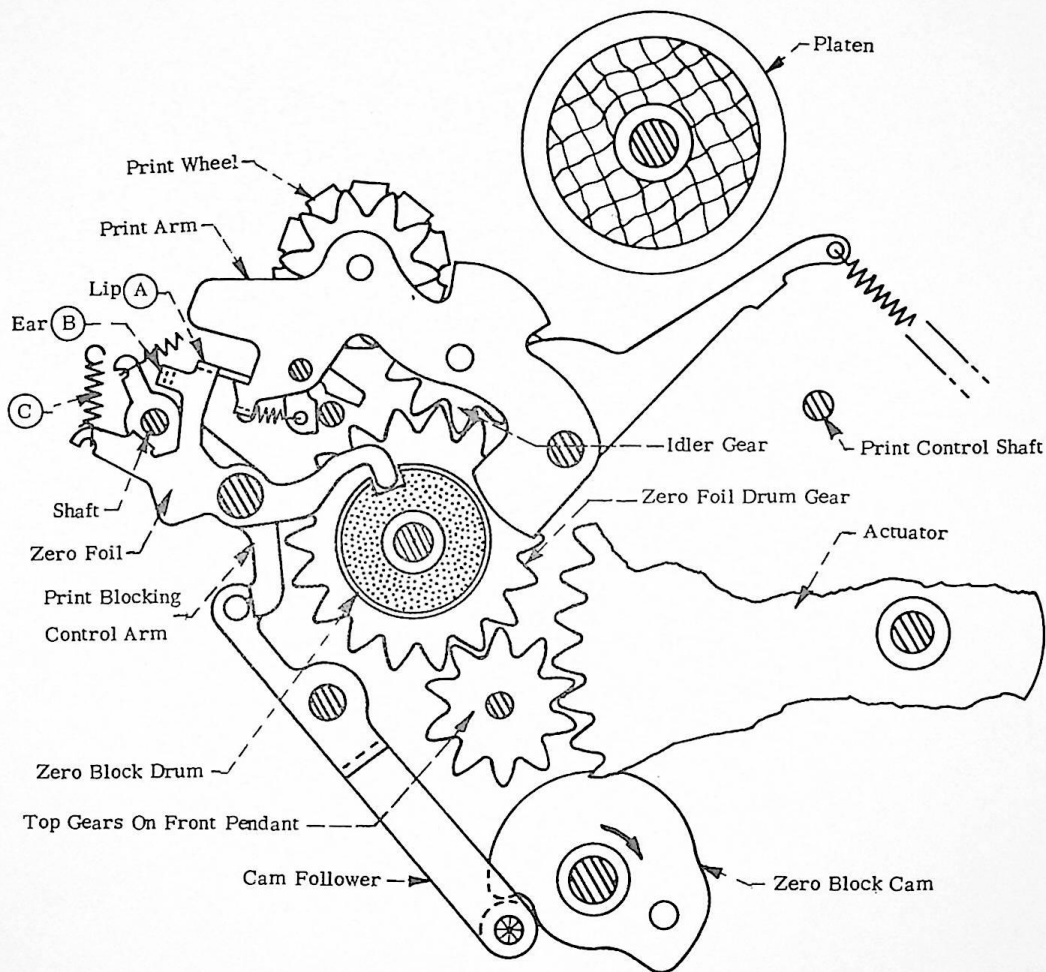
During the accumulator entry cycles of division and multiplication printing and paper feed is blocked by the high speed print control arm which is rocked either up or down to engage ear S and prevent the counter-clockwise movement of the left ribbon control assembly thereby blocking the printing and paper feed. This operation is completely explained in the MULTIPLICATION and DIVISION sections of this manual.



PRINTING
SKETCH 1

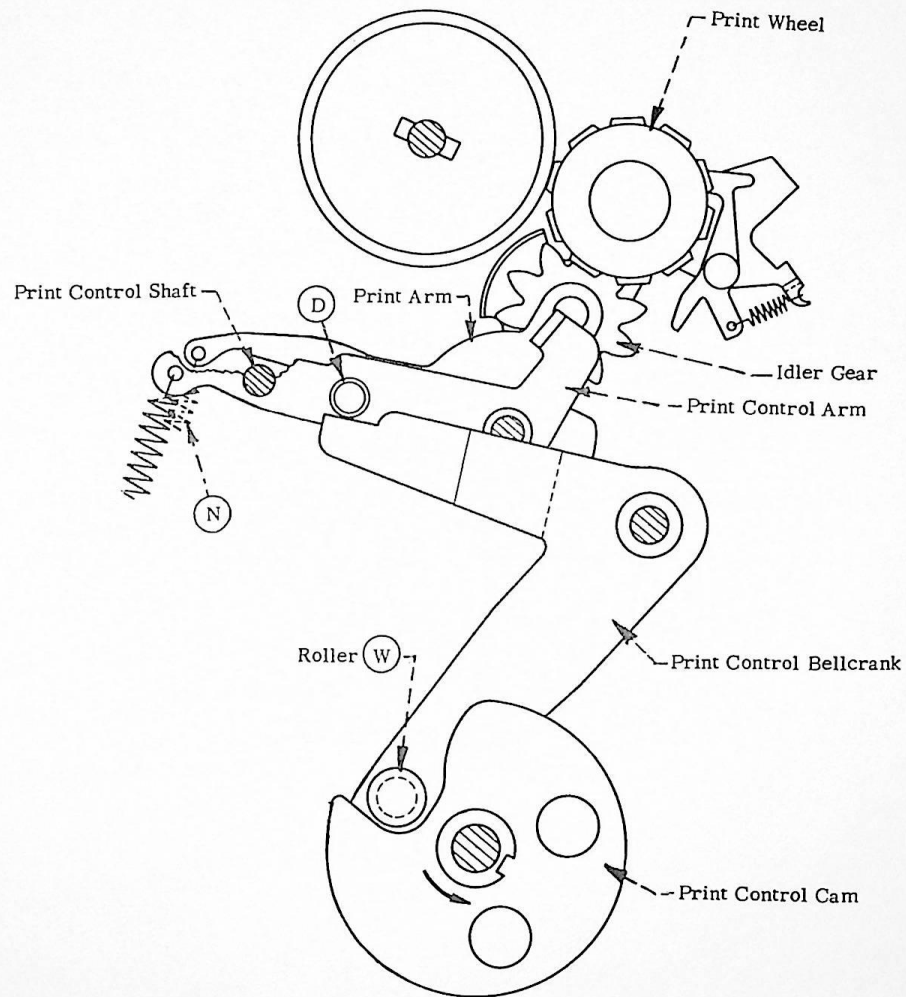


PRINTING
SKETCH 2

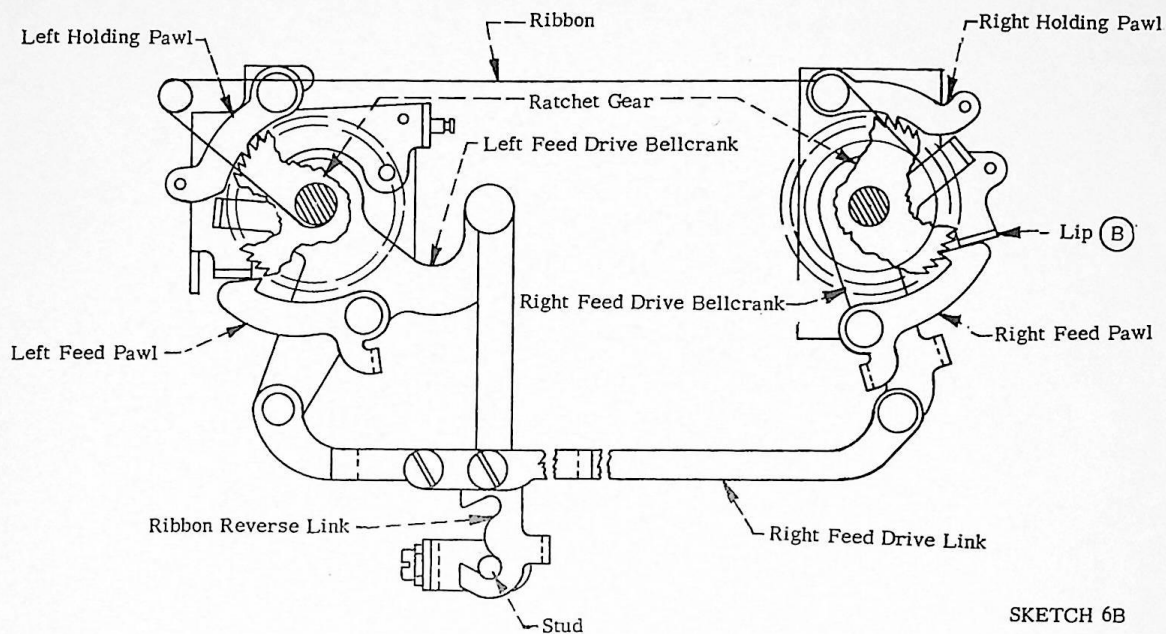


PRINTING
SKETCH 3

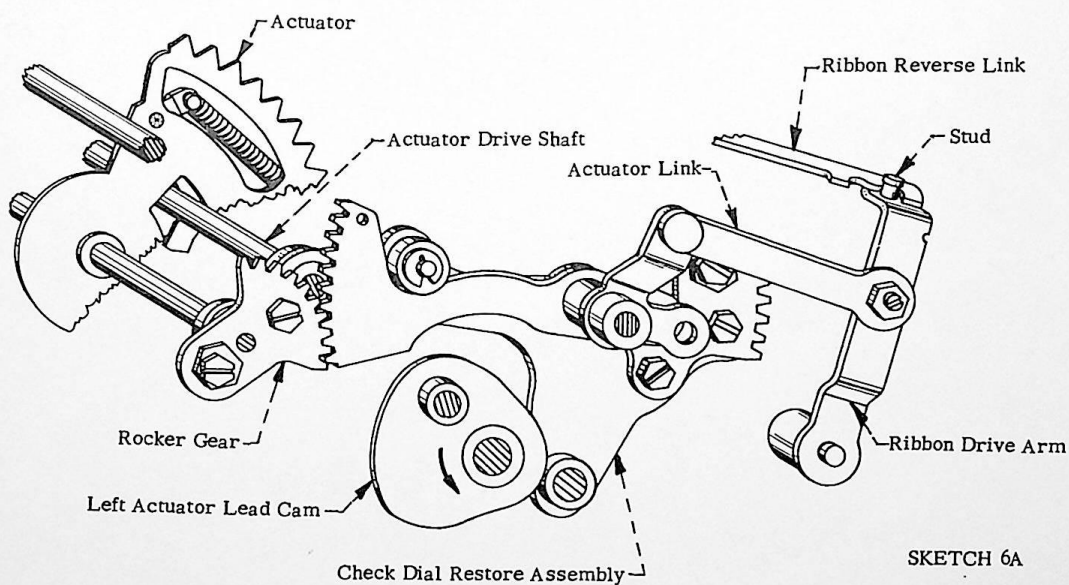
FRIDEN PRINTING CALCULATOR
OPERATIONS - Printing



PRINTING
SKETCH 4

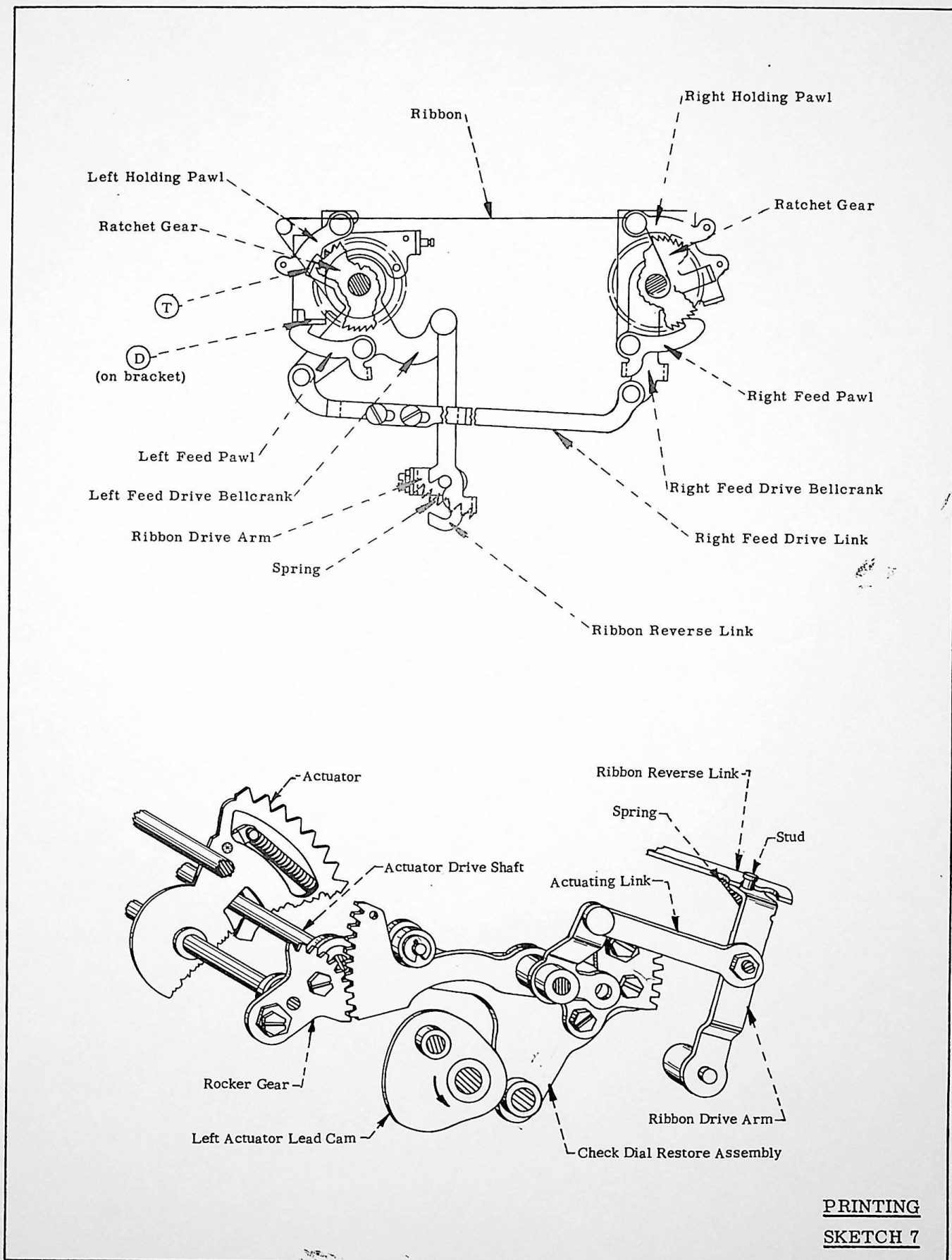


SKETCH 6B



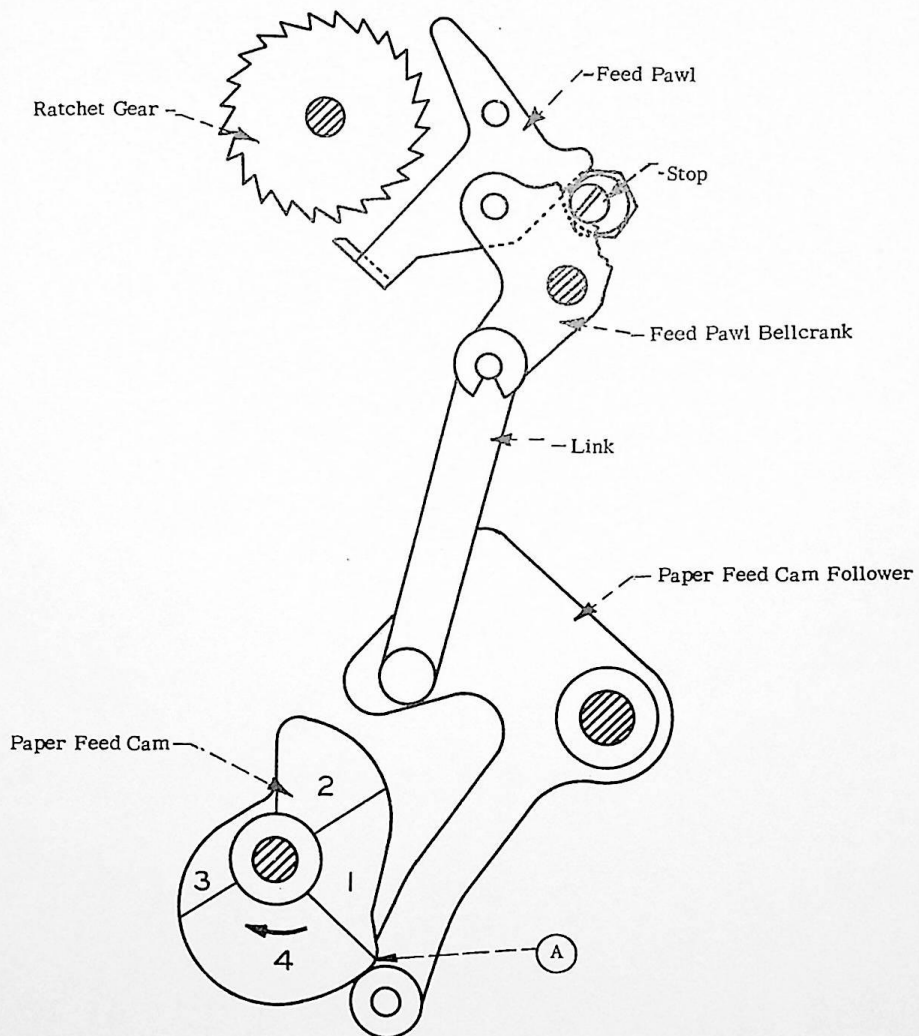
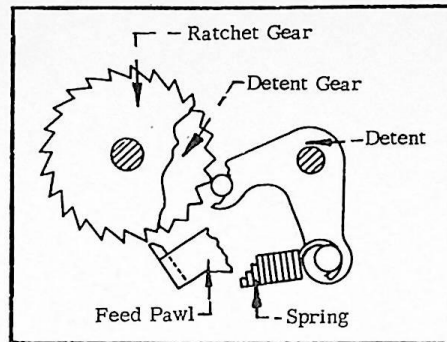
SKETCH 6A

PRINTING
SKETCH 6

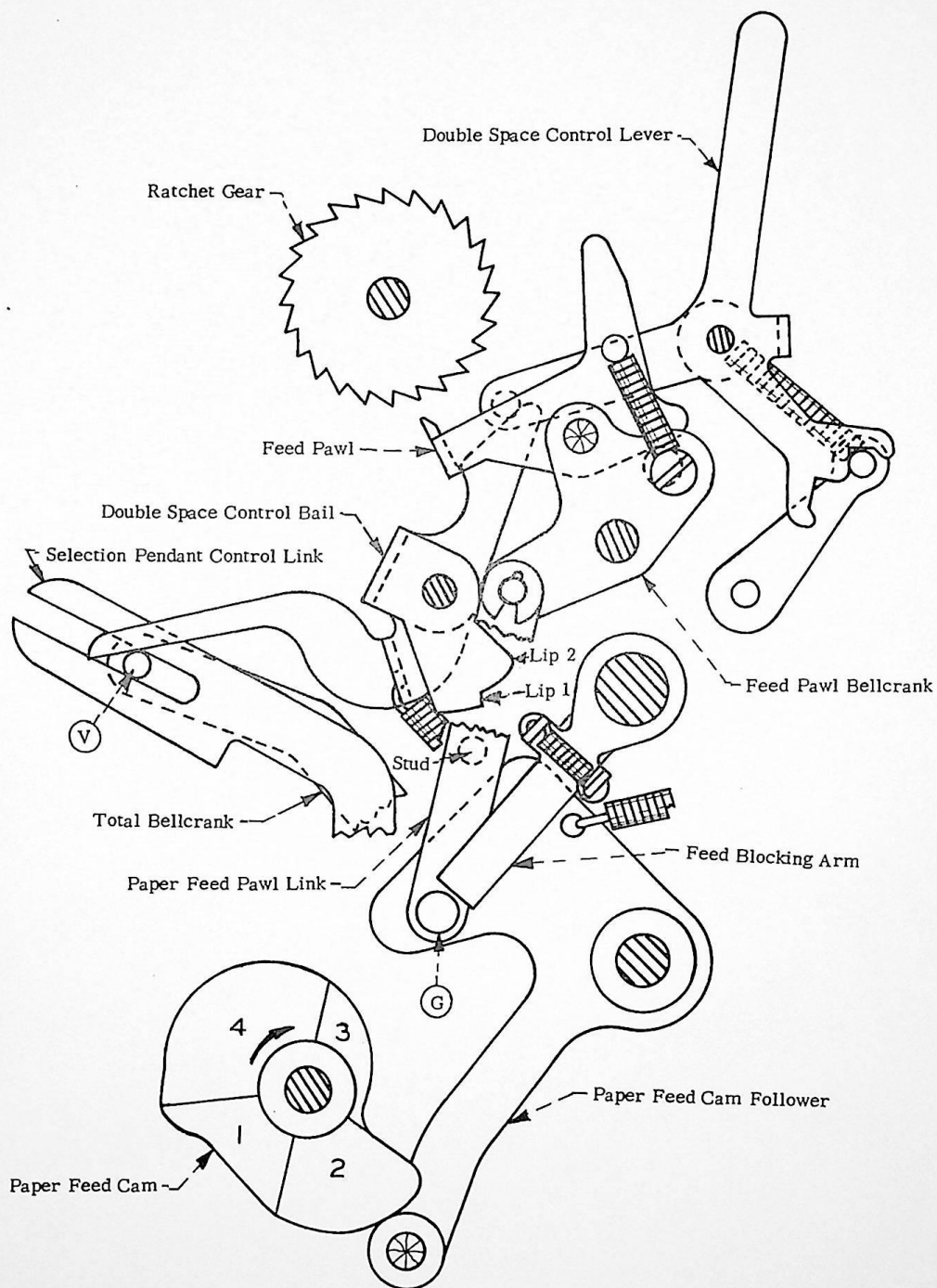


PRINTING
SKETCH 7

FRIDEN PRINTING CALCULATOR
OPERATIONS - Printing



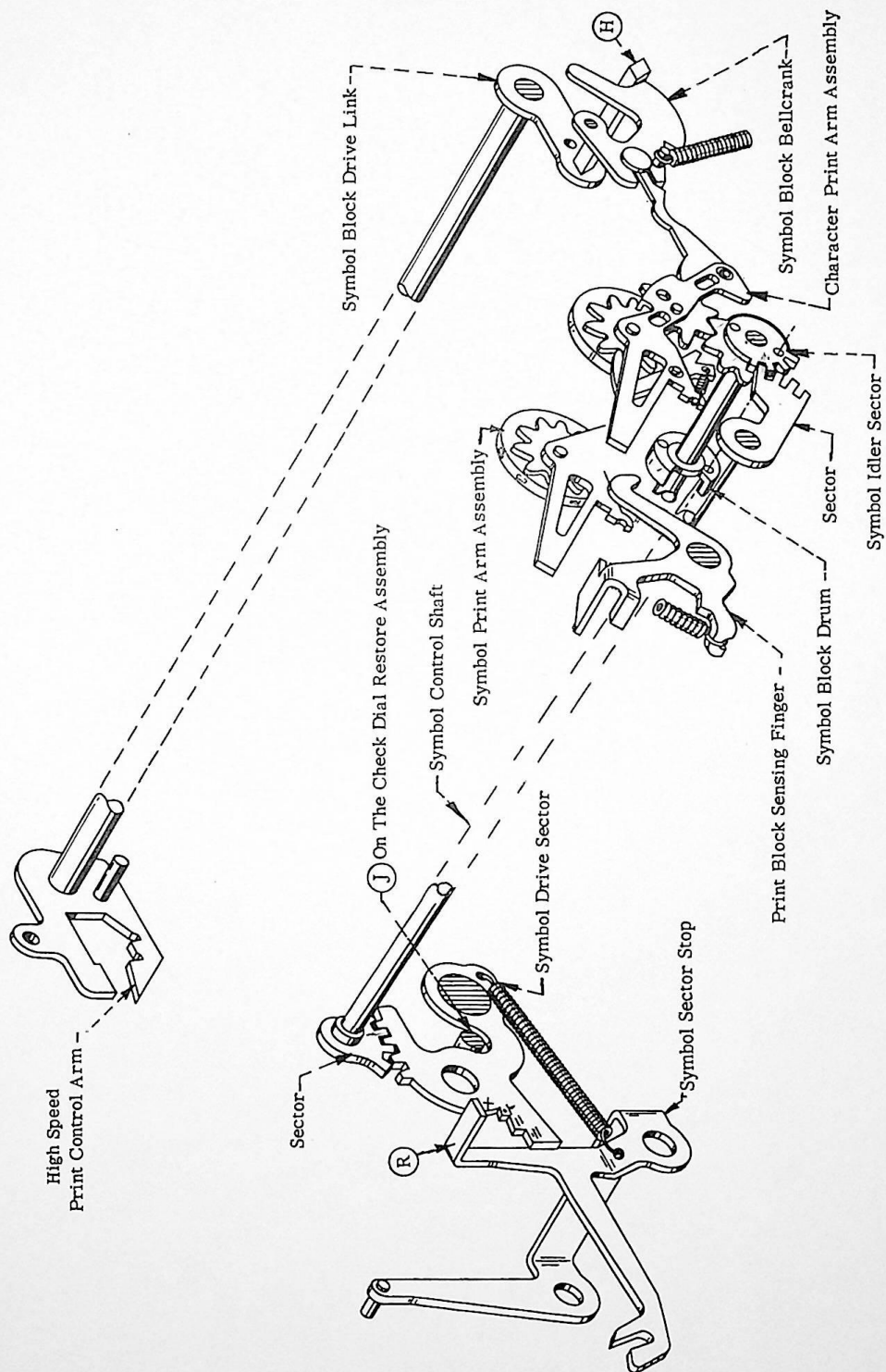
PRINTING
SKETCH 8

FRIDEN PRINTING CALCULATOR
OPERATIONS - Printing

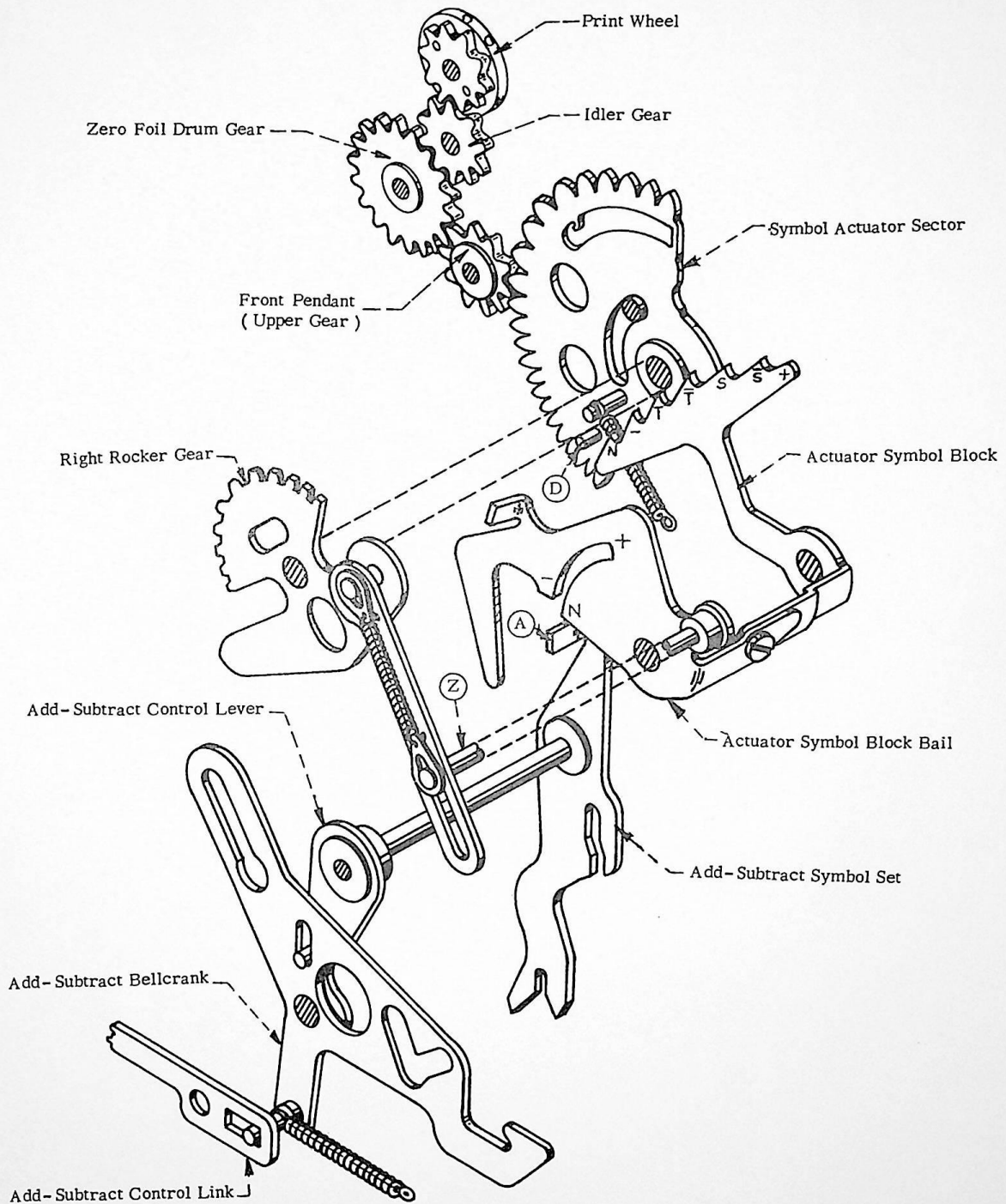
PRINTING
SKETCH 9

FRIDEN PRINTING CALCULATOR

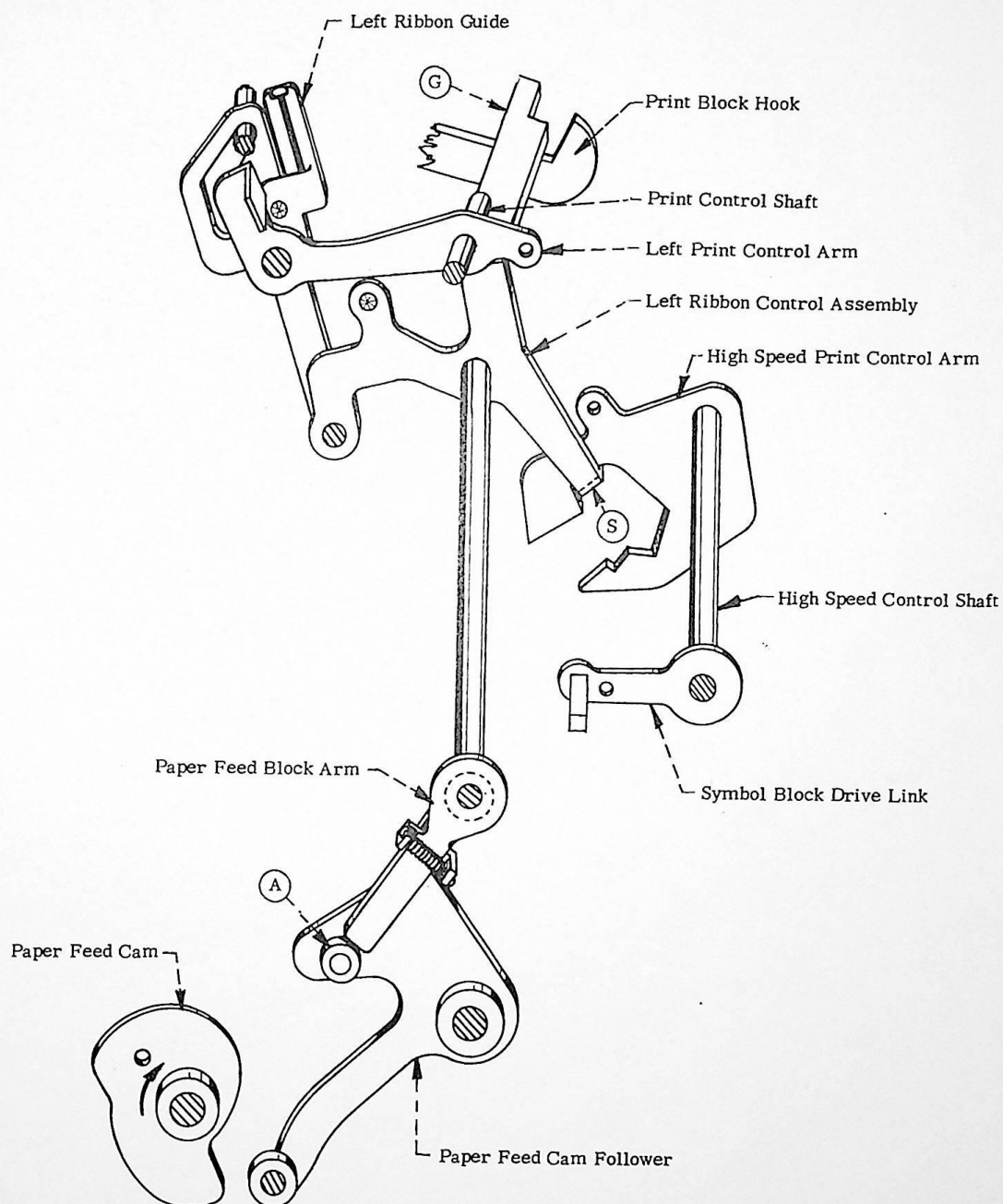
OPERATIONS - Printing



PRINTING
SKETCH 10



PRINTING
SKETCH 11



PRINTING
SKETCH 12

STORAGE UNIT

The storage unit provides a place to store factors from one operation for use in later operations. The multiplier is entered in the storage unit for use during the equals operation. The quotient is entered into the storage unit in division and read out as a "From Memory" operation automatically.

Amounts are entered into and read out of the storage unit by the action of the "Memory" keys. There are two Memory keys, the "To Memory" and the "From Memory". These are not operating keys, that is, they do not start the motor or engage the main clutch. They must be used in conjunction with one of the operating keys. The memory keys cause an "X" to be printed at the right edge of the tape in addition to the symbol for the other key depressed. For example, if the "To Memory" and the "Add" keys are depressed at the same time the amount in the check dials will be printed on the tape with a "+" and an "X" at the right, added into the accumulator, and entered into the storage unit. The storage unit is cleared at the beginning of a "To Memory" operation. If the "From Memory" and the "Subtract" keys are depressed at the same time, the amount in the storage unit will be printed on the tape with a "-" and an "X" at the right, subtracted from the accumulator and restored into the storage unit.

The "X" and the "X²" key work in conjunction with the "To Memory" key to initiate a storage unit entry and a "Non-Add" operation. The amount is entered into the storage unit and printed on the tape but is not entered into the accumulator. With the "X²" key the selection carriage is not cleared.

"X" (TIMES or MULTIPLIER) KEY - Sketch 1

Depression of the "X" key (Sketch 1) causes stud B to cam the left clutch slide forward rocking the clutch throwout shaft to start the motor and engage the main clutch as explained in the MOTOR and DRIVE section. In its home position the add-subtract bellcrank is set for a non add operation and since the controls are not moved by the depression of the "X" key a non add operation will result.

Stud F on the "X" key overlies a lug on the To Memory key and forces that key down when the "X" key is depressed. This conditions the machine for a to memory operation with the result that during the non add operation the figures are also entered into the storage unit sectors in the memory unit.

"X²" (X SQUARED) KEY

The "X²" key initiates a NON ADD and a TO MEMORY operation in the same manner as the "X" key however the selection unit is not cleared.

As the "X²" key is depressed stud Z (Sketch 1) contacts stud F and forces the "X" key and the To Memory key down. This initiates a NON ADD and a TO MEMORY operation as described under "X" key.

Depression of the "X²" key also causes stud H to rock the backspace control lever clockwise. This positions hook K over ear V of the carriage return arm to block the carriage restore. Clockwise movement of the backspace control lever also causes the repeat and the backspace repeat bails to be rocked up to block the sector latches as described in the REPEAT ADD KEY section. When the "X" key is depressed the X key latch is cammed rearward by shaft D and latches under stud F until the "X" key is released at the end of the cycle.

TO MEMORY KEY - Sketch 2

Depression of the To Memory key causes stud A (Sketch 2) to cam the front and rear multiplier slides forward. The To Memory key is held depressed by the memory keys latch. Forward movement of the rear multiplier slide (Sketch 2) pulls stud Y forward to rock the multiplier restore control bellcrank counter-clockwise. This causes stud E to lift the restore push link into the path of stud R on the actuator rocker gear sector.

During the first part of a To Memory operation, while the storage unit sectors are being cleared, ear L of the left lifter bail cam follower is held down by the left lifter bail latch so the lifter bail (Sketch 3) cannot raise the multiplier actuator pawls into engagement with the sectors. (NOTE: There is a lifter bail latch, a lifter bail cam follower, and a lifter bail cam on both sides of the storage unit, only the left side is shown in Sketch 1 but the operation on the right side is identical.) As the restore push link (Sketch 2) moves rearward lug G contacts ear J and rocks the delay arm clockwise. This stretches spring M which, in turn, tries to pull stud T and the left lifter bail latch clockwise, off of ear L. However, spring Q on the left lifter bail cam follower which is much stronger than spring M holds ear L against the step in the lifter bail latch. Friction prevents the left lifter bail latch from rocking clockwise until the left lifter bail cam follower is rocked down.

After the storage unit sectors have been cleared, high point X (Sketch 3) of the left lifter bail cam contacts roller P and rocks the left lifter bail cam follower and ear L down far enough to re-

lease the left lifter bail latch. Spring M (Sketch 2) pulls the left lifter bail latch rearward leaving the lifter bail cam follower free to follow the cam and raise the lifter bail. The lifter bail latches are urged farther rearward by spring M, latching lifter bail cam followers in their raised position.

As the restore push link moves rearward lug W rocks the high speed print control arm and the symbol block drive link down. This rocks stud C down away from the symbol block bellcrank so the "X" symbol can print as described in the PRINTING section.

STORAGE UNIT SECTORS - Sketch 3

A typical order of the storage unit is shown in Sketch 2. The storage unit consists of 16 storage unit sectors, 16 short cut multiplier sectors which are explained in the MULTIPLICATION section, 16 multiplier actuator pawls, and the lifter bail for raising and lowering the pawls.

During the first part of a To Memory cycle, when the actuators are making their downward stroke the lifter bail is latched down and the multiplier actuator pawls are held away from the storage unit sectors. As the actuators are rocked down the multiplier actuator pawls are moved back under the storage unit sectors a number of teeth corresponding to the selection in that order.

When the lifter bail cam followers are released as previously described the lifter bail raises the multiplier actuator pawls into engagement with the storage unit sectors. As the actuators make their upward stroke the storage unit sectors are rotated forward by the multiplier actuator pawls a number of teeth corresponding to the selection in that order.

Near the end of the to memory cycle stud U on the left lifter bail cam rocks the lifter bail latch forward, and the lifter bail cam rocks the lifter bail cam followers down disengaging the lifter bail and returning it to its down position. The lifter bail latches are brought to their home position by spring S. The figures in the storage unit will remain there until the next memory entry operation.

OVERCAPACITY MECHANISM - Sketch 4

To prevent the total number of digits in a product from being greater than the capacity of the accumulator the overcapacity mechanism provides a means of sensing the total number of digits in the multiplier and multiplicand and preventing multiplication from taking place if the product would be overcapacity. Overcapacity termination is

covered under MULTIPLICATION.

During the early part of an "X" operation rearward movement of the restore push link rocks the multiplier sensor restore arm lever counter-clockwise (Sketch 4). This in turn rocks the multiplier sensor restore arm pulling the termination latch drive slide and the multiplier sensor rack to their extreme left position (to the right in Sketch 4) where they are latched in place by ear Z of the multiplier sensing slide latch. Leftward movement of the multiplier sensor rack drives the overcapacity sensor plate, and the multiplier sensor yield their extreme left positions.

The storage unit sectors are rocked counter-clockwise (Sketch 4) as the multiplier is entered. As the sectors rock, ear K of the storage unit detent moves from the zero step to one of the other steps. The zero step on the sector is lower than the other steps so when the sector is in its zero position ear K is on the lower, or zero, step and its tail is raised into the position shown by the dotted lines in Sketch 4. On the other steps the tail is in the lower position shown in Sketch 4.

Near the end of the cycle stud N on the right lifter bail, cams the lifter bail latch restore bellcrank clockwise. This in turn rocks the multiplier sensing slide latch and ear Z down to release the termination latch drive slide. The termination latch drive slide and the multiplier sensor rack are urged to the right (to the left in Sketch 4) by the torsion spring on the multiplier sensor restore arm. Movement of the multiplier sensor rack drives the multiplier sensor yield toward the right.

In those orders of the memory unit in which there is a figure other than zero the tail of the storage sector detent will be in its lower position. Since the orders to the left of the first significant figure of the multiplier will have zeros, the tails of the storage sector detent will be in their upper position. As the multiplier sensor yield is driven to the right it passes under the detents in the zero position and stops against the detent in the order with the first significant figure. Thus, the overcapacity sensor plate and the overcapacity indicator gear slide are lined up with the first, or leftmost figure, of the multiplier. The rightward movement of the termination latch drive slide is also stopped by the multiplier sensor yield so the wide part of the termination block is lined up with the first figure of the multiplier, the purpose of the termination block will be explained later.

TO MEMORY ENTRY - Sketch 3

Sketch 3 shows an example of a "To Memory"

entry using a selection of "5". In Sketch 5A the actuator has rocked down five teeth and the multiplier actuator pawl has been pushed back five teeth from its home position. The sector clear shaft has restored the multiplier storage sector to its home position.

In Sketch 5B the multiplier actuator pawl has been raised into engagement with the storage unit sector, the actuator has completed its upward stroke, and the sector has been rocked five teeth from its home position (note the position of the ear on the multiplier sector detent).

FROM MEMORY KEY - Sketch 6

Depression of the "From Memory" key causes stud V to cam the front and rear multiplier slide rearward. The key is held down by the memory key latch. As the rear multiplier slide moves toward the back of the machine it strikes ear Y (Sketch 6) and rocks the lifter bail delay arm rearward. The left lifter bail latch is attached to the lifter bail delay arm by spring M and rocks rearward with it. This leaves the left lifter bail cam follower free to follow the left lifter bail cam.

Rearward movement of the multiplier slide causes stud B to rock the pendant block control arm and the multiplier restore control bellcrank counterclockwise and stud E lifts the restore push link into the path of stud R on the actuator rocker gear sector. As the actuator rocker gear sector rocks down it drives the restore push link rearward, lug W rocks the high speed print control arm and the symbol block drive link down so the "X" symbol can be printed on the tape.

During a "From Memory" operation accumulator entries are controlled by the storage sectors. Therefore the front pendant must be blocked. The pendant block control arm is rocked rearward by stud B on the rear multiplier slide. This rocks the memory output total interlock rearward which, in turn, rocks the total bellcrank counter-clockwise to raise the selection control link away from ear H so the front pendant cannot be rocked into engagement with the check dial sectors. Rocking of the total symbol control lever would set the controls for a total operation but the memory output total interlock blocks ear U on the total symbol control lever so it cannot rock down.

Since the lifter bail cam followers are not blocked by the lifter bail latches they are rocked counterclockwise by the cams as soon as the drive shaft begins to turn. This raises the lifter bail to put the multiplier actuator pawls in engagement with the storage unit sectors before the downward stroke of the actuators. The lifter

bail latches urged rearward by spring M to latch the lifter bail cam followers in their raised position.

Near midcycle stud M on left lifter bail cam rocks the lifter bail latches forward moving latch away from under ear L on lifter bail cam followers. High point X on lifter bail cam contacts stud P on lifter bail cam followers driving lifter bail down. This is necessary to release lifter bail latch during a to memory operation as explained under to memory key. As drive shaft rotates roller P falls off high point X and lifter bail is raised again to complete the from memory operation. The lifter bail latches are urged rearward by spring M latching lifter bail cam followers in their raised position.

Near the end of the cycle stud T on the left lifter bail cam hits the lower end of the left lifter bail latch and rocks it forward, releasing the lifter bail cam followers. The lifter bail cam followers can now rock down lowering the lifter bail and taking the multiplier actuator pawls out of engagement with the storage unit sectors.

FROM MEMORY READOUT - Sketch 7

Sketch 7 shows a typical order of the storage unit with a "5" stored in the sector. Note the position of the ear on the multiplier sector detent in Sketch 5A. At the beginning of the cycle the lifter bail raises the multiplier pawl to engage the tooth of the storage unit sector as shown in Sketch 5A. As the actuator makes its downward stroke the storage unit sector is rocked back to its zero position. The storage unit sector is stopped in its zero position by the zero stop shaft. At this point the actuator drive latch yields and the actuator drive shaft continues its full stroke. The figures from the storage unit are now printed on the tape and entered into the accumulator, depending upon which key was depressed with the From Memory key.

The lifter bail remains raised so the multiplier actuator pawls remain engaged with the storage unit sectors. As the actuators make their upward stroke the storage unit sectors are pulled back to their original position, in this case a "5", by the multiplier actuator pawls.

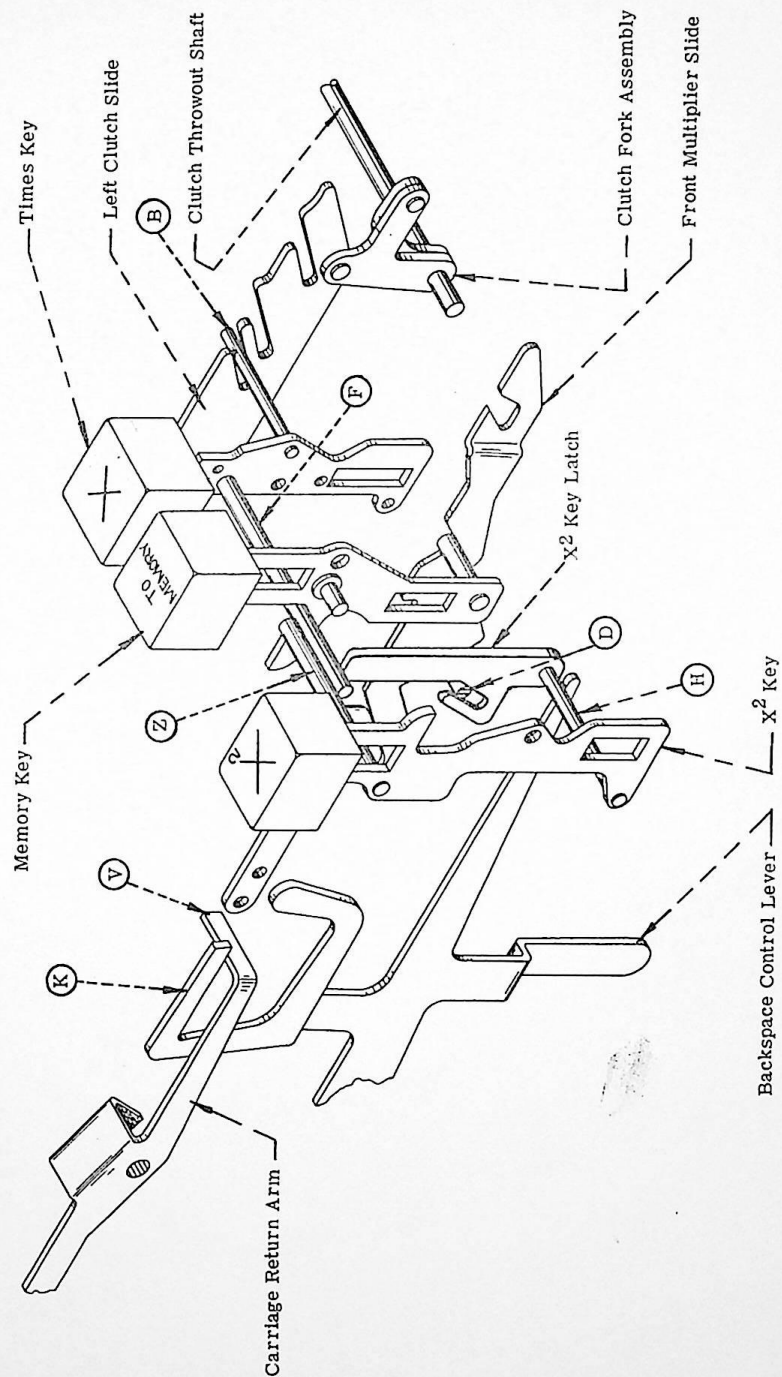
SEVENTEENTH ORDER ACTUATOR BLOCK - Sketch 8

During a From Memory operation the travel of the actuators is limited by the storage unit sectors and the multiplier actuator pawl. Since there is no storage unit sector in the seventeenth order, that actuator would be free to take its full downward stroke, causing a "9" to be printed on

the tape and entered into the accumulator. To prevent this the seventeenth order actuator stop blocks the actuator in the seventeenth order.

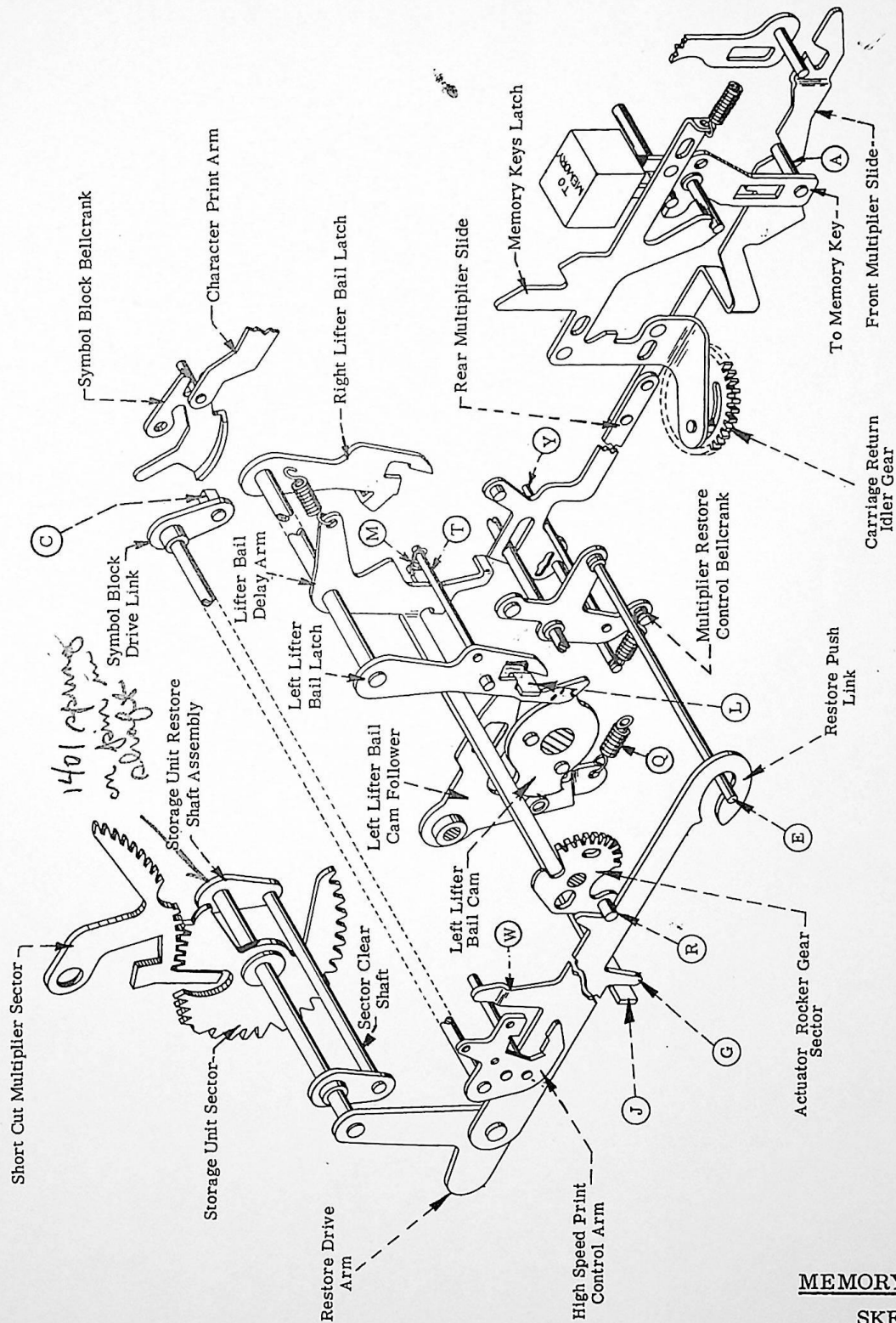
When the left lifter bail latch is rocked rearward at the beginning of a From Memory operation (see Sketch 6) stud D is positioned over the nose of the seventeenth order actuator stop as shown in Sketch 8A. Because of the shape of the slot and the fact that the seventeenth order actuator stop cannot rotate because it is blocked by stud D, stud F is blocked and the actuator cannot rock down. During other operations stud D is clear of the seventeenth order actuator stop and stud F cams the seventeenth order actuator stop down and the actuator is free to rock down.

When a to memory total - sub-total or transfer equals with a 17 column total is taken, the lifter bail is locked out of engagement with the storage unit sectors, and no figure can be entered into the storage unit. Because the lifter bail latch does not move rearward on the first half of a to memory operation, stud D (Sketch 8B) on left lifter bail latch is in its forward position, as the 17th order actuator begins to rotate, stud E cams the 17th order actuator stop clockwise allowing the tail to go behind stud D, blocking rearward movement of lifter bail latch and not allowing lifter bail to be raised. The correct total or sub-total and symbols will be printed with no entry into storage unit even though the "X" is printed.



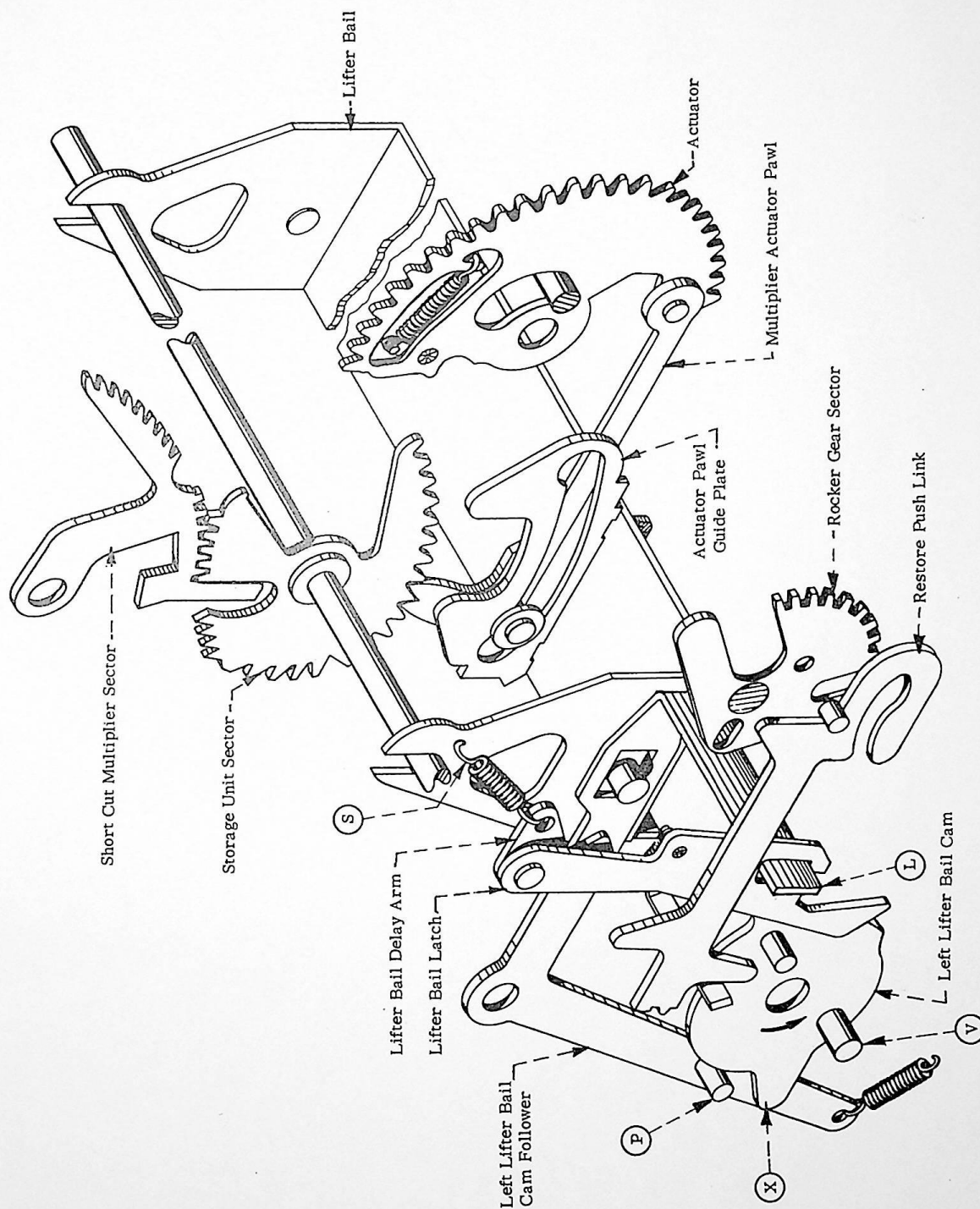
MEMORY UNIT

SKETCH 1



MEMORY UNIT

SKETCH 2

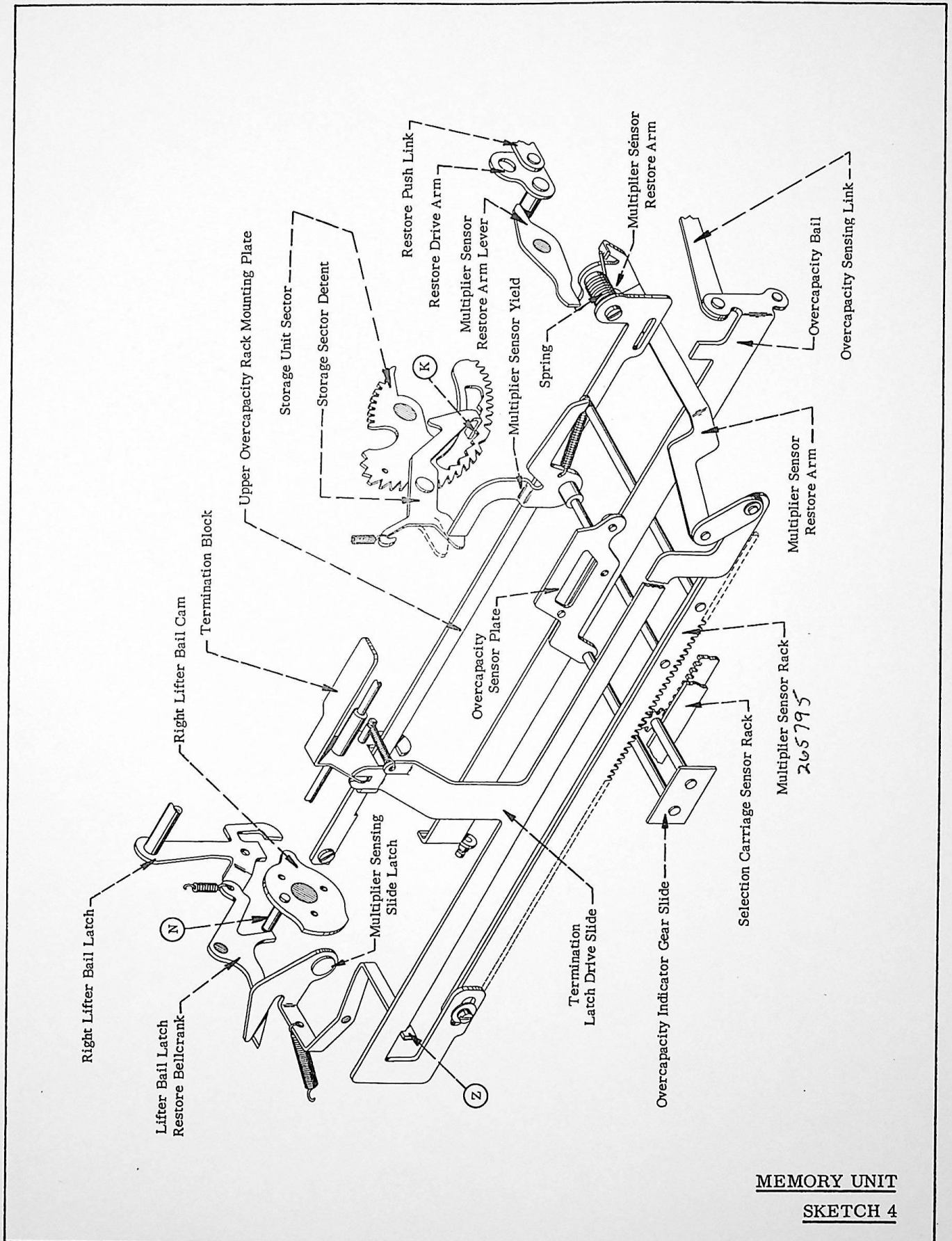


MEMORY UNIT

SKETCH 3

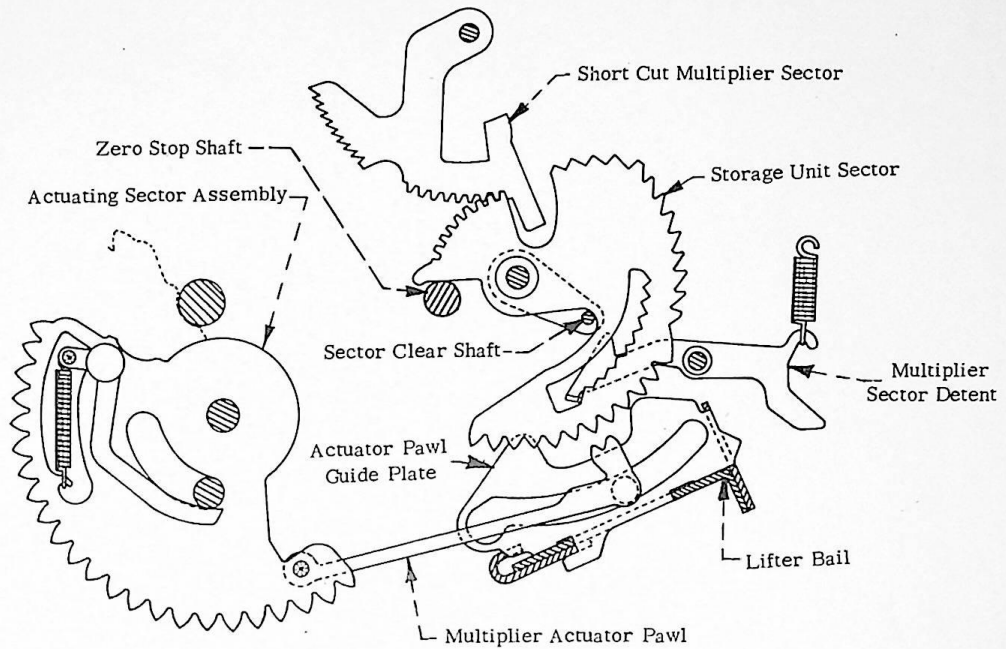
FRIDEN PRINTING CALCULATOR

OPERATIONS - Memory Unit

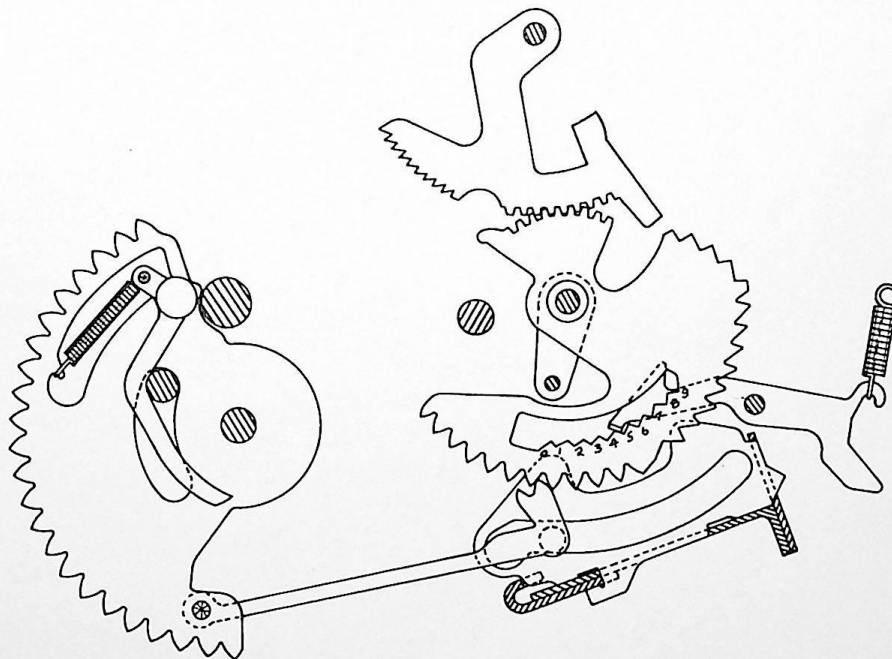


FRIDEN PRINTING CALCULATOR
OPERATIONS - Memory Unit

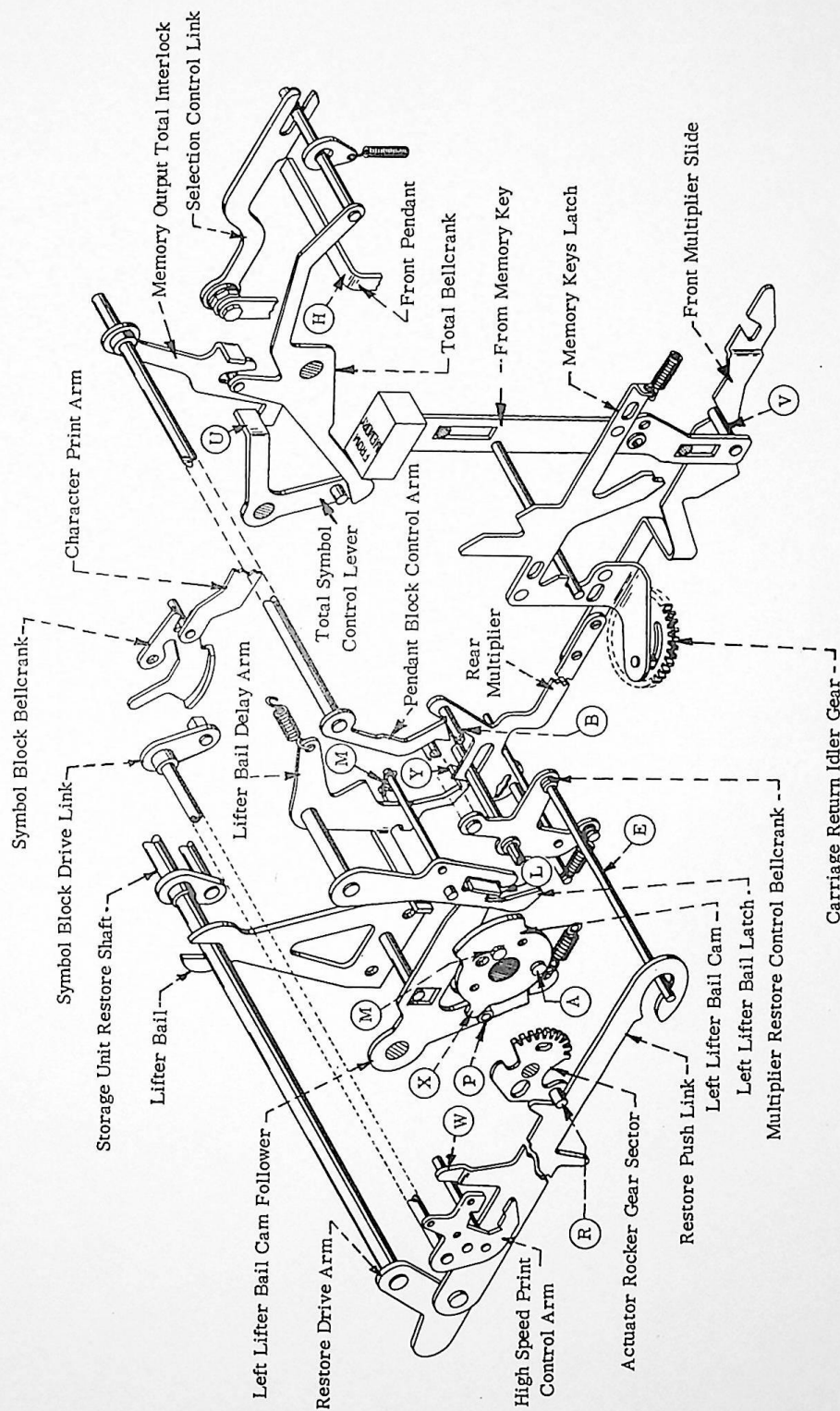
SKETCH 5A



SKETCH 5B



MEMORY UNIT
SKETCH 5

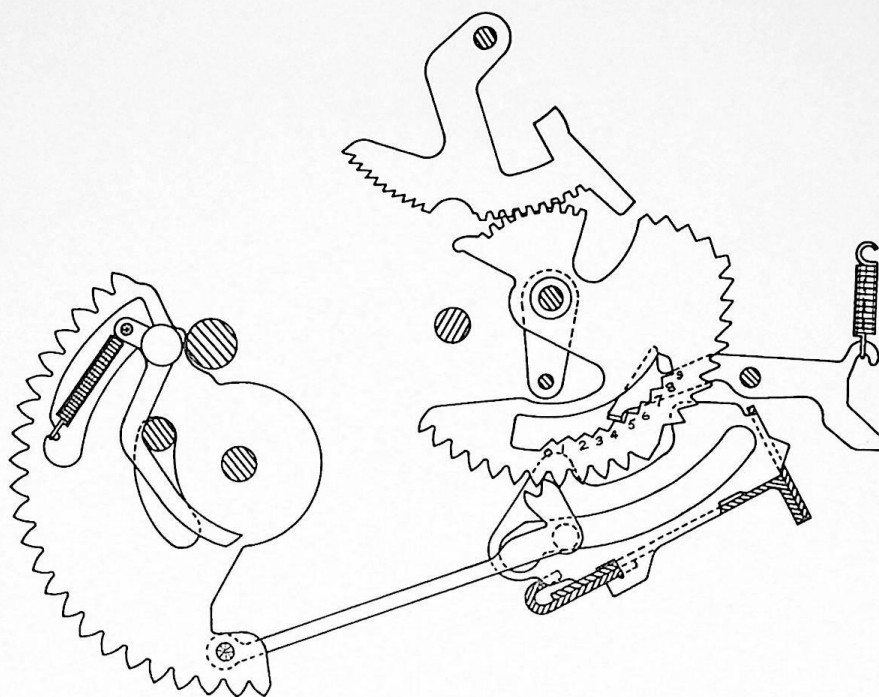


MEMORY UNIT

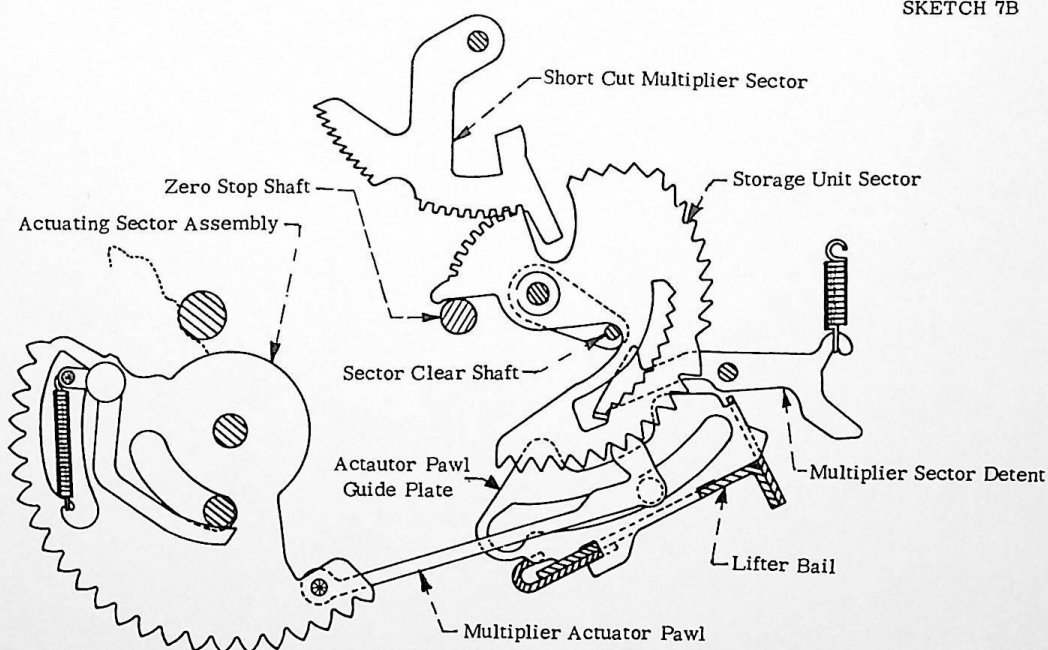
SKETCH 6

FRIDEN PRINTING CALCULATOR
OPERATIONS - Memory Unit

SKETCH 7A

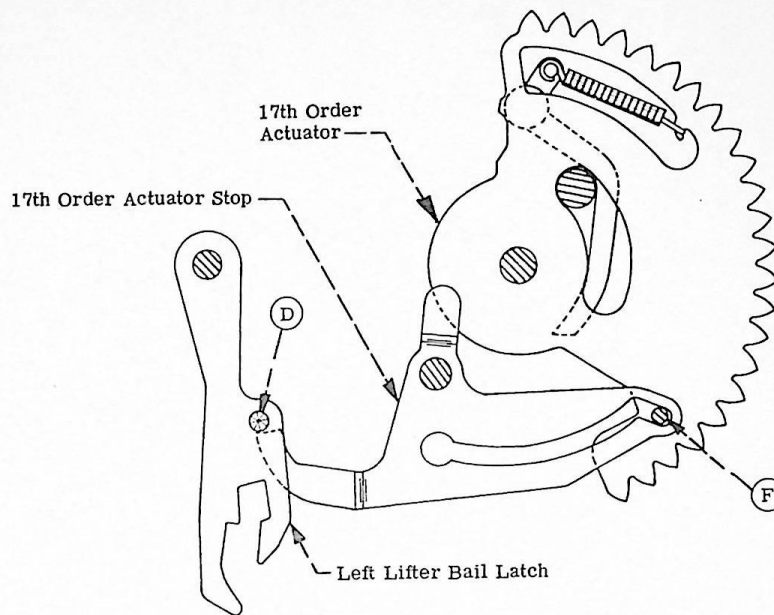


SKETCH 7B

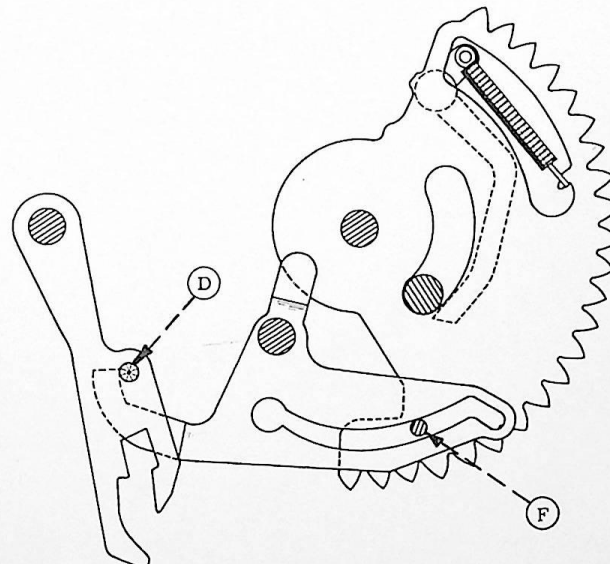


MEMORY UNIT
SKETCH 7

SKETCH 8A

17th Order From Memory Blocking

SKETCH 8B

17th Order To Memory Blocking

VIEWS FROM LEFT

MEMORY UNITSKETCH 8

INTRODUCTION

Multiplication is simply a series of repeat additions performed automatically and controlled by the amount in the memory unit. A multiplication operation on the Printing Calculator consists of two parts: The multiplier entry performed by the "X" key or the "X²" key, and the actual multiplication initiated by one of the equals keys.

"X" (TIMES or MULTIPLIER) KEY. Initiates a NON ADD and a TO MEMORY operation to enter the multiplier into the storage unit and to print the figures on the tape. A "#X" is printed to the right of the multiplier. The carriage is cleared and restored

"X²" (X SQUARED) KEY. Initiates a NON ADD and a TO MEMORY operation to enter the multiplier into the storage unit and print the figures on the tape, however the carriage is not cleared so the number can be used in the following equals operation. A "#X" is printed on the tape to the right of the multiplier. The operation of the "X" and "X²" keys is explained in the previous section (MEMORY KEYS).

EQUALS (=) KEY. Causes the machine to print the multiplicand (number in the selection unit) on the tape with an equals (=) symbol at the right, multiply it by the number in the memory unit, and print the result (product) on the tape. The accumulator and the selection unit are cleared after an equals operation.

ACCUMULATIVE (ACCUM =) EQUALS. Causes the same operation as the Equals key except that the accumulator is not cleared, making it possible to accumulate a series of products. The selection unit is cleared.

TRANSFER (TRANSFER =) KEY. Causes the same operation as the Equals key except that the result is transferred to the memory unit. The accumulator and the selection unit are cleared.

NEGATIVE (NEG =) KEY. Causes the same operation as the Equals key except that the result is inverted, that is instead of being added into the accumulator the multiplicand is subtracted from the accumulator giving a credit balance total (product). The Negative Equals key causes an "=" symbol to be printed on the tape to the right of the multiplicand. The accumulator and the selection unit are cleared.

The Transfer Equals, Accumulative Equals, and the Negative Equals keys may all be depressed together or in any combination to produce the desired results.

Briefly a typical multiplication operation would be done as follows, using $14 \times 12 = 168$ as an example.

The multiplier, in this case "14", is entered into the keyboard. The "X" key is depressed initiating NON ADD and TO MEMORY operations. The multiplier is printed on the tape as ".14#X". The figures are also entered into the first two storage unit sectors in the memory unit.

Then the multiplicand, in this case "12", is entered into the keyboard and the Equals (=) key is depressed. The multiplicand is printed on the tape as ".12 = ". After the first cycle the motor is switched to its higher speed and printing and paper feed are blocked.

The multiplier sensing mechanism includes a probe which senses the figure in the storage unit sector and a ratchet wheel for controlling the number of accumulator entries to be made in each order. In this example a "4" is sensed in the first storage unit sector so the ratchet wheel is rotated 4 teeth out of its home position. On the first and each succeeding machine cycle, as the machine makes an accumulator entry, the ratchet wheel is rotated back one tooth toward its home position. So in the first order the machine adds "12" into the accumulator 4 times. During the last cycle in the first order the ratchet wheel is restored to its home position which causes the sensing probe to be shifted to the left to sense the figure in the second storage unit sector.

The selection unit carriage and the multiplier carriage, which carries the sensing probe, are coupled together by a clutch during multiplication so the selection carriage is also shifted to the left in relation to the accumulator. The machine again begins accumulator entries in the second order with the ratchet wheel being restored one tooth each cycle. In this example there is a "1" in the second sector so the machine will add "120" into the accumulator once.

The machine will continue making accumulator entries and counting out the multiplier in each order then shifting to the left until it reaches the last order in which there is a significant digit, when there are only zeros to the left the machine will automatically begin the termination or product readout cycle.

In this example the "1" in the second order is the last significant digit so after "120" is added into the accumulator, the accumulator entry operations are stopped and the controls are set for a total operation to read out the product from the accumulator during the next machine cycle. The motor is switched back to its lower speed for the last cycle. During the last machine

OPERATIONS - Multiplication

cycle the total is printed on the tape, in this case as "1.68T", the carriage is cleared and restored, and the multiplier carriage and controls are restored to their home positions.

OVERCAPACITY TERMINATION - Sketch 1

The capacity of the accumulator is 17 digits and since the product in multiplication may have one more digit than the total number of digits in the multiplier and multiplicand the machine automatically limits the total number of digits to 16 to prevent incorrect operations. If the total number of digits entered is greater than 16, the overcapacity mechanism will block the multiplication operation. Instead when the Equals key is depressed the machine will perform a non add operation printing the multiplicand as entered and will also backspace the carriage one order. The machine will repeat this non add and backspace operation each time the Equals key is depressed, removing one digit from the multiplicand until the total number of digits is brought within the capacity of the machine. For example if "444444444" was selected and the "X" key depressed and then "333333322" was selected and the Equals key depressed the sum of the digits would be over the capacity of the machine so the machine would print "333333322N" and backspace one order dropping a "2" at the right. If the Equals key was again depressed the machine would print "33333332" and backspace one order dropping the other "2" at the right. This would bring the total number of digits within the capacity of the machine so that when the Equals key is again depressed the equals operation would proceed in the normal manner. The setting of the overcapacity mechanism for the multiplier ("X") entry is described in the previous section.

As the figures of the multiplicand are entered into the keyboard the overcapacity gear sector (Sketch 1) is rocked up one tooth for each order the selection carriage is escaped. Carriage escapement is explained in the SELECTION section. Upward movement of the overcapacity gear sector rocks the overcapacity sensor gear, the intermediate gear, and the idler to drive selection carriage sensor rack toward the left. This in turn drives the overcapacity indicator gear slide and the overcapacity sensor plate toward the left one space for each order the selection carriage is escaped. Since the overcapacity sensor plate was positioned in line with leftmost figure of the multiplier during the "X" key operation, moving one additional space for each order the carriage is escaped has the effect of adding the number of digits in the multiplier and the multiplicand.

If the total number of digits exceeds sixteen the overcapacity sensor plate will be driven into a position where its top edge overlies the overcapacity sensing block. If the Equals key is depressed with the machine in an overcapacity condition the stud on the equals key rocks the equals key latch release fork clockwise. Stud D attempts to pull the automatic backspace lever forward. The automatic backspace lever is fastened to the overcapacity sensing link and attempts to pull that link forward. However, the overcapacity sensing link is fastened to the overcapacity bail and that bail cannot rock forward because it is blocked by the overcapacity sensing block and the overcapacity sensor plate which is held on the bail by studs B. When the overcapacity sensing link cannot move forward, stud D rocks forward in the slot in the front end of the link and cams the automatic backspace lever counterclockwise. Counterclockwise movement of the automatic backspace lever raises ear A away from the equals key release latch so the equals slide cannot be released to set the controls for an equals operation. The automatic backspace lever also rocks the backspace control lever clockwise to set up a backspace operation as described in the SELECTION section.

Depression of the Equals key cams the clutch throwout slide forward to start the motor and engage the main clutch. Since the controls are not moved because the overcapacity condition prevented release of the equals slide the machine will perform a NON ADD and a BACKSPACE operation.

EQUALS KEY - Sketch 2

Depression of the equals key causes stud C to cam the clutch slide forward to initiate a machine cycle as described in the MOTOR and DRIVE section. Stud Z rocks the equals key latch fork and lever, which are part of the same assembly clockwise. The stud on the equals key latch lever pulls the overcapacity sensing link, the automatic backspace lever, and the equals slide latch interponent forward. Ear A on the equals slide interponent rocks the equals key latch clockwise, allowing the tail to release ear M of the equal slide restore bail which is under spring tension and rocks clockwise. The downward movement of stud T, as the equals slide restore bail rocks clockwise, rocks the repeat link and the shaft counterclockwise to disable the single cycle mechanism, as described in the REPEAT ADD section. As the repeat link rocks down, ear G rocks the repeat control bail clockwise, setting the backspace control lever in a position to block ear L of the carriage return arm so the carriage return will be disabled. Clockwise movement of

the equals slide restore bail also moves the equals slide forward, it also rocks stud E and the symbol stop into a position to allow the printing of an equals (=) sign on the tape as explained under "Symbols".

EQUALS SLIDE - Sketch 3

Forward movement of the equals slide moves stud B away from the multiplier sector lock drive, so the spring tension can rock the multiplier sector lock bail into the short-cut multiplier sectors to lock them in place.

Ear G is rocked forward rocking the carriage clutch control pawl counterclockwise, which in turn rocks the clutch control bellcrank to slide the carriage restore clutch plate into engagement with the carriage return clutch to lock the selection and multiplier carriages together. The carriage stop latch is rocked down out of engagement with the carriage overthrow cam to release the multiplier carriage.

The lug on the equals slide moves away from ear Y allowing the print control actuating arm to rock the shaft and the symbol block drive link upward, moving the square stud up, to permit the equals (=) symbol to print.

Stud N (Sketch 3) rocks the ramp cam follower counterclockwise, putting the ramp portion of the lower ear in a position to intercept the stud on the counter release cam.

Ear K rocks the counter ratchet detent out of engagement with the multiplier ratchet, allowing the multiplier shaft to rotate. The counter ratchet detent delay latch is spring urged forward over ear S of the counter ratchet detent to hold the detent out of engagement with the multiplier ratchet until 150° of the machine cycle, this allows sufficient time for the multiplier sensing unit to sense the storage sectors.

HIGH SPEED AND PRINT BLOCKING - Sketch 4

During the first machine cycle of an Equals key operation the multiplicand is printed on the tape and then the motor is switched to its higher speed and printing is blocked.

As the equals slide (Sketch 4A) moves forward lug A moves away from the ear on the print control actuating arm this allows spring W to rock the high speed print control shaft counterclockwise. This rocks the symbol block drive link up raising the square stud D above the shelf of the symbol block bellcrank leaving the equals symbol print arm free to print.

As the high speed print control shaft rotates counterclockwise the live tip on the high speed print control arm stops against ear Z of the left ribbon control assembly. This allows the shaft to rotate far enough to raise stud D above the shelf but not far enough to operate the high speed switch. As the left ribbon control assembly rocks counterclockwise during the printing portion of the cycle, ear Z drops off the live tip (Sketch 4B) and onto the first step of the high speed print control arm. This permits the left ribbon control assembly to rock only far enough to print in the black portion of the ribbon, so the multiplicand is always printed in black even during a negative equals operation. Ear T also rocks clear of the print control shaft so printing can take place.

After printing takes place the left ribbon control assembly rocks clockwise causing ear Z to drop off the first step of the high speed print control arm and onto the second step (Sketch 4C) the live tip yields to permit this. The high speed print control arm will hold the left ribbon control assembly in this position, with ear T under the print control shaft so printing is blocked during the multiplication operations.

When ear Z drops to the second step of the high speed print control arm, the high speed print control shaft rocks counterclockwise farther. This causes roller M on the high speed bellcrank driver to cam the high speed bellcrank counterclockwise pulling the high speed latch down. This in turn pulls the switch operating lever down to actuate the high speed microswitch.

The controls will remain in this condition with printing blocked and the motor switched to high speed operation until the last cycle when the total is printed. Restoring these controls is described under "Termination" later in this section.

ACCUMULATOR ENTRY SIGN CONTROL - POSITIVE ENTRY - Sketch 5

Multiplier entries can be made into the accumulator in two ways: Normal, that is, counted-in in a plus direction, or short-cut, which will be explained later. The numbers causing normal entry are 1, 2, 3, and 4. Numbers 5, 6, 7, 8, and 9 cause short-cut entries.

As the multiplier is entered into the storage unit sectors the short-cut multiplier sector is also rocked a corresponding amount. When the equals key is depressed the forward movement of the equals slide (Sketch 3) rocks the counter ratchet detent out of engagement with the multiplier ratchet, allowing the multiplier sensing unit to move in, the multiplier ratchet rotates clockwise moving stud B (Sketch 5) away from the zero block. The

zero block rocks clockwise away from roller S, allowing the sign sensing arm and the sign sensing bail to drop down. Clockwise movement of the zero block cam also positions the notch so ear F can enter if there is a multiplier other than zero. Zero multipliers will be explained later.

With "normal entry" numbers the sign sensing bail is held in its home position by the tail of the short-cut multiplier sector. This, in turn, holds the sign sensor arm and the negative equals link in their home position. The ear on automatic add-subtract interponent is spring urged against ear N of the negative equals link, ear P is held in the path of ear Y of the automatic add-subtract bellcrank.

Early in the first cycle of an equals key operation the automatic add-subtract control latch is rocked clockwise by the stud on the add-subtract control drive cam. This lifts the notch in its lower arm clear of the square stud on the add-subtract drive cam follower. At about this same time the counter follower block is rocked counterclockwise, its tail holds the automatic add-subtract control latch in its clockwise position with the notch clear of the square stud during the rest of the equals operation. This leaves the add-subtract drive cam follower free to follow the add-subtract drive cam. As the roller on the add-subtract drive cam follower drops toward the low of the cam the add-subtract actuator link is driven forward. This, in turn, rocks the automatic add-subtract bellcrank clockwise until ear Y stops against ear P. This rocks the add-subtract symbol set into its plus position as shown in Sketch 5A, which conditions the machine for a positive entry into the accumulator.

During the last half of each machine cycle the add-subtract control drive cam rocks the add-subtract drive cam follower clockwise, this rocks ear F out of the notch of the zero block and allows the automatic add-subtract bellcrank to return to its home position. If the multiplier ratchet is not in its zero position the parts return to their positions before the beginning of the next machine cycle. During each machine cycle the multiplier ratchet is rotated one tooth counterclockwise, as it is rotated into its home, or zero, position stud B rocks the zero block under roller S to raise the sign sensing arm and the sign sensing bail so the multiplier carriage shift and sensing in the next order are completed at about 290°, this is shown in Sketch 10.

Just before the end of each cycle (about 330°) the roller on the add-subtract drive control cam follower drops back into the notch in the cam. So the controls for the next cycle are set before the previous one is completed.

ACCUMULATOR ENTRY SIGN CONTROL SHORT-CUT ENTRY - Sketch 6

In order to increase the speed of doing a multiplication problem the printing calculator is provided with a mechanism for "Short cut" multiplication. In short cut multiplication the complement of multipliers "5" to "9" is used. The complement of a number is ten minus the number, for example, the complement of "9" is "1" ($10 - 9 = 1$), the complement of "8" is "2" ($10 - 8 = 2$). With short cut multipliers, "5" to "9", the multiplicand is entered into the accumulator in a minus direction and a "1" is "carried" or added to the multiplier in the next order to the left. Multipliers "1" to "4" always are entered into the accumulator in a plus direction. A "0" multiplier will block the entry of any figures into the accumulator and only cause a carriage shift.

To multiply "9" times "4" in the conventional way, "4" would be entered into the accumulator in a plus direction 9 times for a total of 36. With short cut multiplication the complement of "9" or "1" is used as the multiplier. The "4" is entered into the first order of the accumulator once in a minus direction, leaving the accumulator at minus 4. Then the multiplier and selection carriages are shifted one order to the left, and since a "1" was carried a "4" is entered into the accumulator in a plus direction. This is the same as multiplying 4 times 10 and entering a plus 40 into the accumulator. So we have entered a minus 4 and a plus 40 into the accumulator which leaves the accumulator at plus 36. This took only two machine cycles rather than nine with the conventional method. So short cut multiplication consists of multiplying the multiplicand by the complement of the multiplier and subtracting this amount from ten times the multiplicand.

This same principle can be extended to multipliers of any length for example: 389 times 23. In this case "9" is the first multiplier and is a short-cut number therefore its complement "1" is used, so "23" is entered into the accumulator in a minus direction and a "1" is carried to the next multiplier. So the accumulator now stands at minus 23. The carriages shift and the next multiplier is sensed. The next multiplier is 8 which is also a short-cut number so its complement is used, however there was a "1" carry so instead of making two minus entries only one is made. This is the same as making two minus entries and one plus entry for the carry. The accumulator now stands at minus 253. A "1" is carried and the carriages shift and the multiplier in the third order is sensed in this example "3". Since "3" is not a short-cut number the machine will make 3 plus entries into the accumulator and one for the carry or a total of four plus

entries into the accumulator. This leaves the accumulator standing at the correct total 8947.

On "Short-cut" numbers, 5 to 9, the sign sensing bail can drop into the notch of the short cut multiplier sector as shown in Sketch 6. The sign sensing arm is pinned to the shaft on which the sign sensor bail pivots. As the sign sensing bail rocks down into the short-cut multiplier sector on a short-cut number, as shown, the shaft on which it pivots is also lowered. This, in turn, lowers the sign sensor arm and rocks the negative equals link down. Ear N pivots the automatic add-subtract interponent to raise ear P out of the path of ear Y on the automatic add-subtract bellcrank so the add-subtract symbol set can be rocked into its negative position. This conditions the machine for a negative entry into the accumulator.

The operation of add-subtract drive cam follower and the automatic add-subtract bellcrank are the same as previously described for positive entries except that since ear P is raised the automatic add-subtract bellcrank can rock farther clockwise and stop against the bumper this conditions the machine for a negative entry into the accumulator.

When the sign sensing bail rocks down to sense a short-cut number (Sketch 6) its tail rocks the termination block hook down pulling the short-cut release link up so ear V is engaged by the short-cut latch. This provides the necessary carry to the next order which will be explained later.

ZERO BLOCK - Sketch 7

If there is a zero multiplier in any order the machine must go through one cycle to perform the necessary testing operations and to shift the multiplier carriage to the next order. Since zero times any number is zero, there must be no accumulator entry on this cycle.

When the multiplier ratchet is released to sense a zero multiplier it rotates less than one tooth space out of its home position. The zero block subtract drive cam follower cannot enter the notch in the zero block. This prevents the rocking of the add-subtract drive cam follower and holds the add-subtract actuator link in its rearward position. Since the add-subtract actuator link cannot move forward the automatic add-subtract bellcrank will not be rocked counterclockwise, the ear of the add-subtract symbol block will be held rearward and the machine conditioned for a non-add operation, and no entry will be made into the accumulator.

The testing of the multiplier in the next order and shifting during this cycle are the same as for any other number and are described on previous pages.

COUNTER FEED - Sketch 8

Forward movement of the equals slide (Sketch 3), upon depression of the equals key, rocks the counter ratchet detent out of engagement with the multiplier ratchet, leaving it and its shaft free to rotate under tension of spring H. This allows the multiplier sensing unit to move in and sense the figure in the first storage unit sector. The multiplier ratchet is rotated a number of teeth corresponding to the figure in the storage sector. As the rear drive shaft begins to turn, the stud on the counter release cam rocks the ramp cam follower counterclockwise. The lug on the ramp cam follower picks up stud E (Sketch 8A) and raises the equals slide. Ear Y is lifted releasing stud M, however, the counter ratchet detent is still held out by the counter ratchet detent delay latch. The ramp cam follower is held in its counterclockwise position by the equals slide control latch until the end of the equals operation. As the ramp cam follower rocks counterclockwise it contacts ear R of the counter follower block and rocks it rearward. This allows ear C to drop off the upper step of the counter follower block and into the position shown in Sketch 8A, releasing the counter feed cam follower to follow the counter feed cam. The counter feed pawl is also released by the rearward movement of the counter follower block and is spring urged into a position to engage the teeth of the multiplier ratchet. The counter feed pawl is spring loaded against ear C of the counter feed cam follower. As the counter feed cam follower is rocked by the cam the counter feed pawl is driven in to engage a tooth of the multiplier ratchet as shown in Sketch 8B. At the same time stud B on the counter feed cam follower (Sketch 8C) rocks the counter ratchet detent delay latch away from the counter ratchet detent releasing it to engage the multiplier ratchet.

The counter feed cam drives the counter feed pawl against the multiplier ratchet rotating it counterclockwise almost two teeth. The movement of the counter feed pawl is stopped by the counter overthrow bracket as shown in Sketch 8D, this limits the rotation of the multiplier ratchet to less than two teeth. As the counter feed pawl withdraws the ratchet rotates back until engaged by the counter ratchet detent.

Each machine cycle the multiplicand is entered into the accumulator and the multiplier ratchet is rotated one tooth counterclockwise until the

figure in the first storage sector has been counted out and the overstroke of the multiplier ratchet initiates a shift of the multiplier and selection carriages. The above counting process will then continue in the next order and succeeding orders until the last storage sector with a figure in it is reached.

CARRIAGE SHIFT - Sketch 9

The multiplier ratchet is rotated one tooth counterclockwise on each machine cycle until it reaches its home, or zero, position. As the multiplier ratchet is rotated into its home position the overstroke carries stud D against the zero block and raises it. Stud A on the zero block rocks the zero sensing latch clockwise pulling the multiplier shift link to the rear which in turn rocks the shift bellcrank up. This rocks ear R on the multiplier escapement pawl into a tooth space of the selection escapement rack. Ear R rocks the escapement pawl down, out of engagement with the selection escapement rack, allowing the carriage to shift slightly to the left. As the multiplier ratchet rocks back from its overstroke position to its home position, the zero block rocks down, allowing the zero sensing latch to rock counterclockwise rocking the multiplier escapement pawl out of the selection escapement rack and allowing the carriage to shift one order to the left. Since the selection carriage and the multiplier carriage are clutched together during multiplication the multiplier carriage will also shift one order to the left.

Stud X normally rests against the end of the zero sensing latch. As the zero sensing latch is rocked clockwise stud X is released and the zero sensing bail attempts to rock clockwise, however hook F engages the upper overcapacity rack mounting plate and prevents the zero sensing bail moving very far in all orders except the last. Termination in the last order will be explained later.

As the next machine cycle starts, the stud on the counter release cam rocks the zero sensing bail follower clockwise to restore the zero sensing bail. As the multiplier ratchet is released in the next order, stud A is rocked away from the zero sensing latch, allowing it to drop down and block stud X to hold the zero sensing bail in place.

COUNTER RELEASE - Sketch 10

The ramp cam follower is rocked counterclockwise by the forward movement of the equals slide (Sketch 3) releasing stud E from notch G (Sketch 10A). This leaves the counter release follower free to follow the counter release cam. As the rear drive shaft begins to turn, the stud on the counter release cam rocks the ramp cam follower further counterclockwise causing it to rock the counter follower block to the rear, see Sketch 8. As the

counter follower block moves rearward, it contacts stud W (Sketch 10A) and pushes the counter release interponent block off stud T.

Since the ramp cam follower is latched in its rearward position (Sketch 8) the counter follower block is also held in its rearward position during the multiplication operation. Stud W (Sketch 10A) is also held to the rear and the counter release interponent cannot relatch on stud T.

Near the end of each machine cycle the roller on the counter release follower is spring urged into the notch in the counter release cam. This rotates the upper end of the follower and the counter release interponent towards the rear of the machine. If the multiplier ratchet is not in its home position, the counter release interponent will be in its lower position as shown in Sketch 10A. As the counter release interponent is driven toward the rear of the machine the arm with the forked end will contact the ear on the counter overthrow bracket to stop the rearward movement. Since the lower arm of the counter release interponent is held below stud M, it cannot push the counter ratchet detent out of engagement with the multiplier ratchet.

After the figure in each order of the multiplier is counted out, the multiplier ratchet is rotated to its overstroke position causing a multiplier carriage shift as previously described. After the multiplier carriage has shifted to the next order the counter release interponent is rocked rearward; however, since the multiplier ratchet is now in its zero position, stud A will hold the interponent in the position shown in Sketch 10B, so the lower arm can contact stud M and rock the counter ratchet detent out of engagement with the multiplier ratchet, allowing the shaft to turn and the multiplier sensing unit to sense the figure in that order.

During the last machine cycle, or termination operation, the counter follower block will be rocked forward to a position where it is no longer blocking stud W, so as the counter release follower is rocked toward the rear the counter release interponent block is spring urged back up on stud T.

MULTIPLIER SENSING - Sketch 11

At the beginning of an equals operation the multiplier sensing unit is in alignment with the first, or rightmost, order of the storage unit. As the equals slide moves forward (Sketch 3) the counter ratchet detent releases the multiplier ratchet allowing it to rotate clockwise. This causes the multiplier sensing gear, which is mounted on the same shaft, to rotate, driving the multiplier sensing unit against either the storage unit sector or the tail on the short-cut multiplier sector.

Either a step on the storage unit sector or the tail of the short-cut multiplier sector, depending upon the selection, is placed in a position to intercept ear A or ear B (Sketch 11A) of the multiplier sensing unit. If the multiplier is a "0" through "4", ear A will stop against the corresponding step on the storage unit sector and the multiplier ratchet will be rotated an equivalent number of teeth. In Sketch 11B(1), a "4" multiplier is shown, note that ear A is stopped against the "4" step and the multiplier ratchet has been rotated four teeth.

If the multiplier is a short-cut number "5" through "9" ear B will stop against the tail of the short-cut multiplier sector and the multiplier ratchet will be rotated from 5 to 1 teeth respectively.

There are only five positions for the multiplier ratchet, this is because of short-cut multiplication. As explained previously, multipliers "1" through "4" cause the multiplicand to be entered additively into the accumulator one to four times respectively. Short-cut multipliers "5" through "9" cause the multiplicand to be entered subtractively into the accumulator five to one times respectively.

Sketch 11B(2) shows a "9" multiplier, note that ear B is against the tail of the short-cut multiplier sector, which has been rocked to its "9" position, and the multiplier ratchet has been rotated one tooth, the sign sensing bail has dropped down setting the controls for a subtractive entry as shown in Sketch 6. Sketch 11B(3) shows a "5" multiplier, the short-cut multiplier sector is in its "5" position and ear B has stopped against it, the multiplier ratchet has rotated five teeth and the sign sensing bail is set for subtractive operation.

SHORT-CUT CARRY - Sketch 12

As explained previously, under "Short-Cut Multiplication", short-cut multipliers cause the multiplicand to be entered subtractively into the accumulator and a "1" to be added to the multiplier in the order to the left.

When the sign sensing bail is rocked down to test a short-cut multiplier (Sketch 6) it also rocks the termination blocking hook down, which in turn pulls the short-cut release link forward to a position where its ear can be latched by the short-cut latch. As the multiplier is counted out, the multiplier sensing unit is driven rearward by the action of the multiplier ratchet. If the short-cut release link is latched forward ear C (Sketch 12A) will contact stud R and as the multiplier sensing unit is driven into its home position the multiplier sensing finger will be cammed up. The spring urged short-cut mechanism latch moves stud N

under the multiplier sensing finger to hold it in a raised position.

With the multiplier sensing finger lifted up the positions of the sensing ears A and B are reversed. Ear A now is in a position to stop against the short-cut multiplier sector and ear B will stop against one of the steps on the storage unit sector. This provides the necessary plus "1" carry because the multiplier ratchet will be rotated one tooth further when ear B instead of ear A stops against steps "0" through "4" of the storage unit sector and an additional plus entry into the accumulator will result.

When ear A instead of ear B stops against the storage unit sector the multiplier ratchet will be rotated one less tooth. Therefore, with "5" through "9" multipliers, with a short-cut carry there will be one less minus entry into the accumulator, which is the same as a plus "1" entry.

After the last number with a short-cut carry is being counted out the short-cut latch releases the short-cut release link and as sensing unit rack is moving rearward during counting a projection at the rear end of the short-cut mechanism latch strikes ear X on the short-cut release link and is pushed forward to allow ear A to drop to its normal position.

Sketch 13B shows a "445" multiplier, the upper picture shows the sensing of the "5" in the first order, ear B has stopped against the short-cut multiplier sector and the multiplier ratchet has rotated 5 teeth, the sign sensing bail is in its minus position so the multiplier sensing finger will be rocked up to provide a short-cut carry as previously described. The machine is conditioned to make five minus entries into the accumulator and "carry" a plus "1" to the next order. The middle picture shows a "4" with a carry, the multiplier sensing finger has been raised so ear B is stopped against step "4" on the storage unit sector, note that this has allowed the multiplier ratchet to rotate five teeth. The sign sensing bail is in its plus position, so the machine will make five plus entries into the accumulator and there will be no carry. The lower picture shows the "4" in the third order, since there is no carry the multiplier sensing finger has been released by stud N and is in its lower position, ear A is stopped against the "4" step of the storage unit sector and the multiplier ratchet has been rotated four teeth. The sign sensing bail is in its plus position so there will be four plus entries into the accumulator and there will be no short-cut carry.

Sketch 13C shows a "99" multiplier. The upper picture shows the "9" multiplier in the first

order. Since there is no carry from the previous order, ear B is stopped against the tail of the short-cut multiplier sector and the multiplier ratchet has been rotated one tooth. The sign sensing bail is in its minus position so the machine is conditioned to make one minus entry into the accumulator. Since the sign sensing bail is in its minus position, there will be a short-cut carry to the next order. The middle picture shows the "9" in the second order. Since there is a "carry" from the first order, the multiplier sensing finger is raised and ear A is stopped against the tail of the short-cut multiplier, the multiplier ratchet is rotated one less tooth and one less minus entry into the accumulator. In this case, a "9" with a short-cut carry, the multiplier ratchet is rotated to zero, which is less than one tooth. The zero block does not drop far enough for the ear of the add-subtract cam follower to enter the notch (see "Zero Block - Sketch 7") so there is no entry into the accumulator. The sign sensing bail is in its minus position so there will be a short-cut carry to the next order. The bottom picture shows a "0", with a "carry" in the third order. Since there is a "carry" the multiplier sensing finger is held up and ear B is stopped against the "0" step of the storage unit sector. This allows the multiplier ratchet to rotate one tooth. The sign sensing bail is in its plus position so the machine is conditioned to make one plus entry into the accumulator and there will be no short-cut carry. In multiplying by "99" the machine has multiplied the figures in the selection unit by 100, the plus entry in the third order; and subtracted 1, the minus entry in the first order ($100 - 1 = 99$). However, because of the manner in which the machine operates it did it in reverse order, in other words, it subtracted 1 and then multiplied by 100.

As the last figure in the multiplier is counted out, the machine is conditioned to begin the termination operations, these will be explained on the following pages. However, if the last, leftmost, figure in the multiplier is a short-cut number ("5" to "9") there will be a carry to the "0" in the next order, as in the example above with "99". To prevent termination, the termination blocking hook is rocked down by the short-cut release link, Sketch 12A, into a position to prevent the zero sensing bail from rocking down. The bail will be held until the short-cut latch is released at 265° of the plus entry operation set up by the carry.

TERMINATION - Sketch 13

During the last counting cycle which is the next to the last machine cycle, most of the controls are restored to their home position and the machine prepared for printing out the total on the last cycle.

At the beginning of an Equals operation the termination block is lined up with the leftmost figure of the multiplier. When the multiplier is counted out in this order the machine will begin the termination operation unless there is a short-cut carry as explained in the previous section in which case the machine will make one additional counting cycle in the next order.

In each order as the multiplier ratchet is rotated back to its zero position stud H raises the zero block causing stud V to rock the zero sensing latch clockwise to initiate a carriage shift. The zero sensing latch also rocks away from stud D releasing the zero sensing control bail which is spring urged clockwise. However, in all orders except the last one the hook on the lower end of the termination block engages the overcapacity mounting plate and prevents movement of the zero sensing control bail. In the last order tail P of the multiplier carriage cams against the wide part of the termination block as shown in Sketch 13. This rocks the termination block counter-clockwise and moves the hook out of engagement with the overcapacity mounting plate. Therefore, in the last order of the multiplier when the zero sensing latch releases stud D the zero sensing control bail can rock farther clockwise. Arm L rocks down the equals slide control latch to release the ramp cam follower which is spring urged clockwise. This allows the equals slide to drop down and ride on bail R of the counter release cam follower. This also allows the notches in the equals slide to drop over the ears of the automatic total-subtotal clutch arm and the carriage clutch control pawl.

Clockwise movement of the ramp cam follower allows the counter follower block to be spring urged forward to set the counter feed cam follower and the counter feed pawl to be latched during the next cycle.

Near the end of the cycle the counter release follower drops to the low of the cam. This rocks bail R forward so ear Y can drop behind it. As the counter release cam continues to turn, bail R is rocked rearward pulling the equals slide to the rear. Rearward movement of the equals slide pulls the automatic total-subtotal clutch arm to the rear setting the controls for a total operation on the next cycle. Rearward movement of the equals slide also rocks the carriage clutch control pawl and the clutch control bellcrank to release the carriage return clutch so the carriages can be restored separately. As the counter release follower reaches the high of the cam stud F latches in the notch in the ramp cam follower, this holds the counter release follower in its home position.

As the zero sensing control bail rocks down its right end rocks the switch latch trip bellcrank counterclockwise which in turn rocks the high speed latch back to release the switch operating lever and the high speed microswitch.

Rearward movement of the equals slide also rocks the equals slide restore bail counterclockwise. This restores the repeat link and repeat shaft (Sketch 2) so the single cycle mechanism can operate the main clutch. However this happens too late in this cycle, so the machine will make one more cycle. The repeat control bail and the backspace control lever are also restored so the carriage can be cleared and restored on the next cycle.

The equals slide is held in its rearward position with ear Y hooked on bail R until the next cycle.

PRINTING TOTAL - Sketch 14

During the last machine cycle the total is read out of the accumulator and printed on the tape and any mechanisms not previously restored are returned to their home positions.

Rearward movement of the equals slide, previously described, pulls ear C toward the rear of the machine, rocking the automatic total clutch arm counterclockwise in Sketch 14. This, in turn, rocks the total-subtotal drive arm to set the total-subtotal control lever in its total position. This conditions the controls for an accumulator readout as described under "Total".

At the beginning of the last machine cycle the cycle lock moves up to lock the totalsubtotal control lever in its total position. Shortly after this, stud X on the counter release cam contacts the bottom of the equals slide and lifts the ear off the bail of the counter release follower, allowing the equals slide to return forward to its home position under spring tension.

The machine will continue through the total cycle and since the clutch controls have been returned to a single cycle condition, the machine will stop at the end of this cycle. The clutch slide will be moved rearward to release the equals key. Since the carriage return arm is no longer blocked, the selection carriage will be cleared and restored to its home position. Restoring the selection carriage also causes the backspace rack to move rearward and restore the multiplier carriage as shown in the inset.

ACCUMULATIVE EQUALS KEY - Sketch 15

Depression of the accumulative equals (ACCUM=) key causes the machine to go through an equals

operation except the total is retained in the accumulator. That is, instead of a total operation during the last machine cycle to read out the accumulator, a subtotal is taken.

The accumulative equals key has a stud which overlies an arm on the equals key. When the accumulative equals key is depressed, the equals key is also pulled down to initiate the equals operations previously described. Depression of the accumulative equals key also causes stud A to rock the automatic total bellcrank and pull the accumulative equals link forward.

This rocks the automatic total-subtotal bellcrank to lift the automatic total-subtotal idler arm against stud E. During the total operation previously described, the automatic total-subtotal drive arm was rocked by stud T. During an accumulative equals operation as the automatic total clutch arm is rocked counterclockwise by the rearward movement of the equals slide, the automatic total-subtotal idler arm is rocked by stud K against stud E on the total-subtotal drive arm. Since stud E is only half as far from the shaft, or pivot point, as stud T the same amount of rearward movement by the automatic total-subtotal clutch arm will rock the shaft and the total-subtotal control lever twice as far when applied at stud E.

This conditions the machine for a subtotal operation on the last cycle. The printing and restore portions of the last cycle are the same as previously described under "Printing Total - Sketch 14".

NEGATIVE EQUALS KEY - Sketch 16

The negative equals key provides a negative product, or total, or will subtract the result of a multiplication operation from an amount previously in the accumulator.

The negative equals key has a stud B which overlies an ear on the equals key. When the negative equals key is depressed the equals key is also pulled down to start the machine in an equals operation as described previously.

It was previously described under "Accumulator Entry Sign Control" how short-cut multipliers "5" to "9" cause a minus entry into the accumulator and "1" to "4" multipliers cause a plus entry during an equals key operation. Since a negative product is required with the negative equals key, the accumulator entry control must be reversed, so that short-cut multipliers cause a plus entry.

As the negative equals key is depressed the neg-

OPERATIONS - Multiplication

active equals control lever (Sketch 16A) is rocked down, camming stud P and the negative equals control arm clockwise. This rocks the negative equals symbol interponent into a position to block stud K on the equals symbol control to position the symbol stop for the printing of a negative equals symbol ($\bar{=}$) on the tape.

As the negative equals control arm is rocked clockwise the negative equals link is pulled forward into the position shown in Sketch 16A.

If there is a "1" to "4" multiplier in the storage sector, the sign sensing bail will be stopped in its upper position, as shown in Sketch 16A. This positions ear Z of the negative equals link over ear L of the automatic add-subtract interponent to hold ear D out of the path of the ear on the automatic add-subtract bellcrank. When the add-subtract actuator link rocks the automatic add-subtract bellcrank, as explained under "Accumulator Entry Sign Control", the bellcrank can rock to its furthest clockwise position stopping against the bumper. This rocks the add-subtract symbol set, which is fastened to the same shaft, into its minus position and conditions the machine for a minus entry into the accumulator.

When there is a short-cut multiplier during a negative equals operation, the sign sensing bail and the sign sensing arm drop the negative equals link lower and arm W (Sketch 16B) stops the automatic add-subtract interponent in a position in which ear D blocks the automatic add-subtract bellcrank to hold the add-subtract symbol set in a plus position as shown, so the machine will make the required plus entry into the accumulator.

The remainder of the operation is the same as

previously described for the equals key.

TRANSFER EQUALS KEY - Sketch 17

The transfer equals key causes the machine to transfer the product, or total, from an equals operation into the storage unit. The transfer equals key has a stud A which overlies an ear on the equals key. When the transfer equals key is depressed the equals key is pulled down to initiate an equals operation as described previously.

Depression of the transfer equals key also rocks transfer total bellcrank down to place surface C against stud Y on the equals slide restore bail. As the equals slide moves forward to start the equals operation, the equals slide restore bail is rocked down so stud Y cams over surface C and underneath ear V of the transfer total bellcrank as shown in Sketch 17.

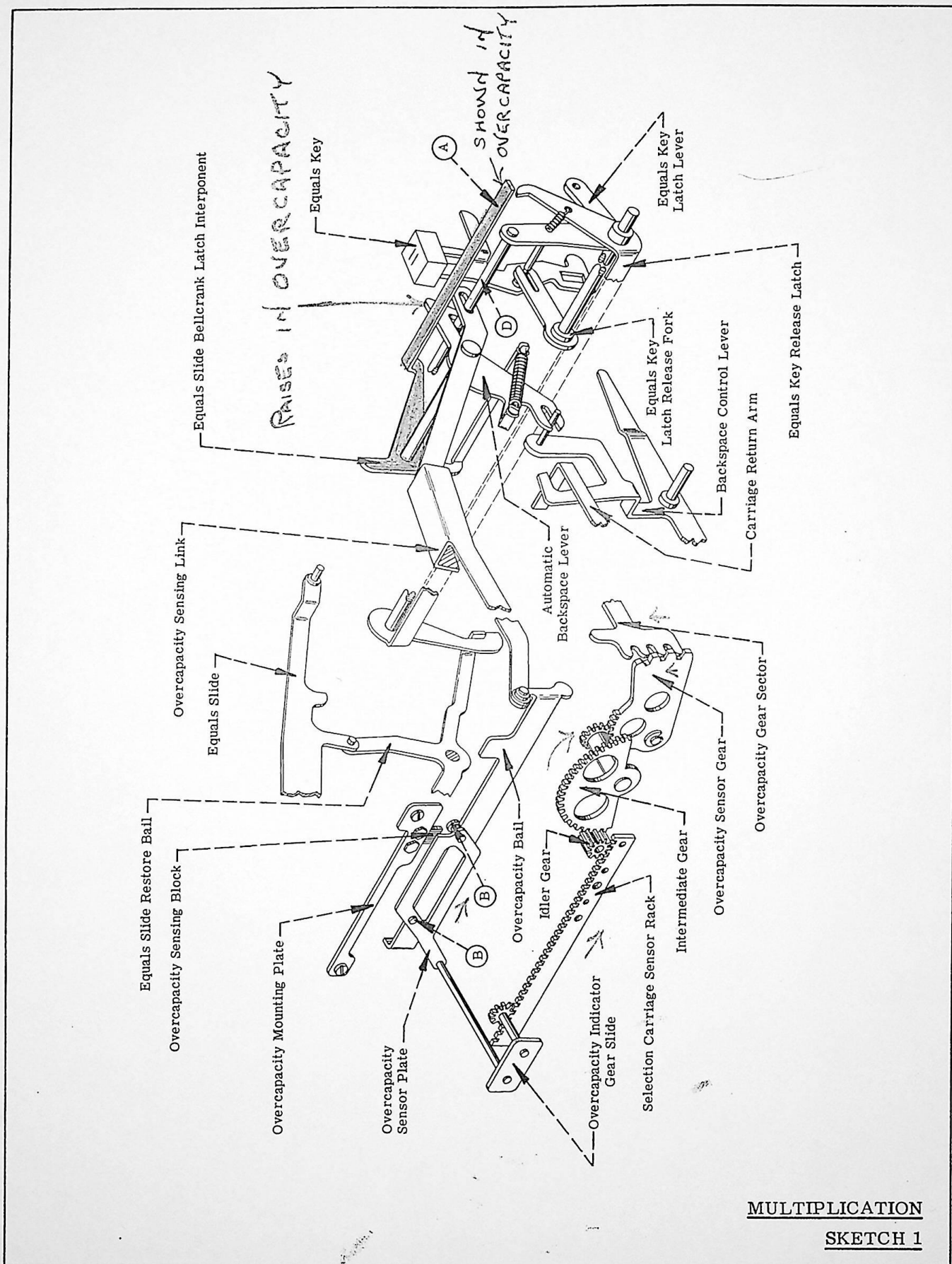
At the end of the equals operation, the equals slide is pulled rearward, as described under "Termination". This rocks the equals slide restore bail up. Stud Y lifts ear V of the transfer total bellcrank causing it to pivot around stud F. This lifts stud S against surface J of the front multiplier slide camming it forward to condition the machine for the transfer operation.

On the last machine cycle, as the total is read out of the accumulator, it is transferred into the storage unit in the manner described under "To Memory".

The remainder of the transfer equals operation is the same as previously described for the equals operation.

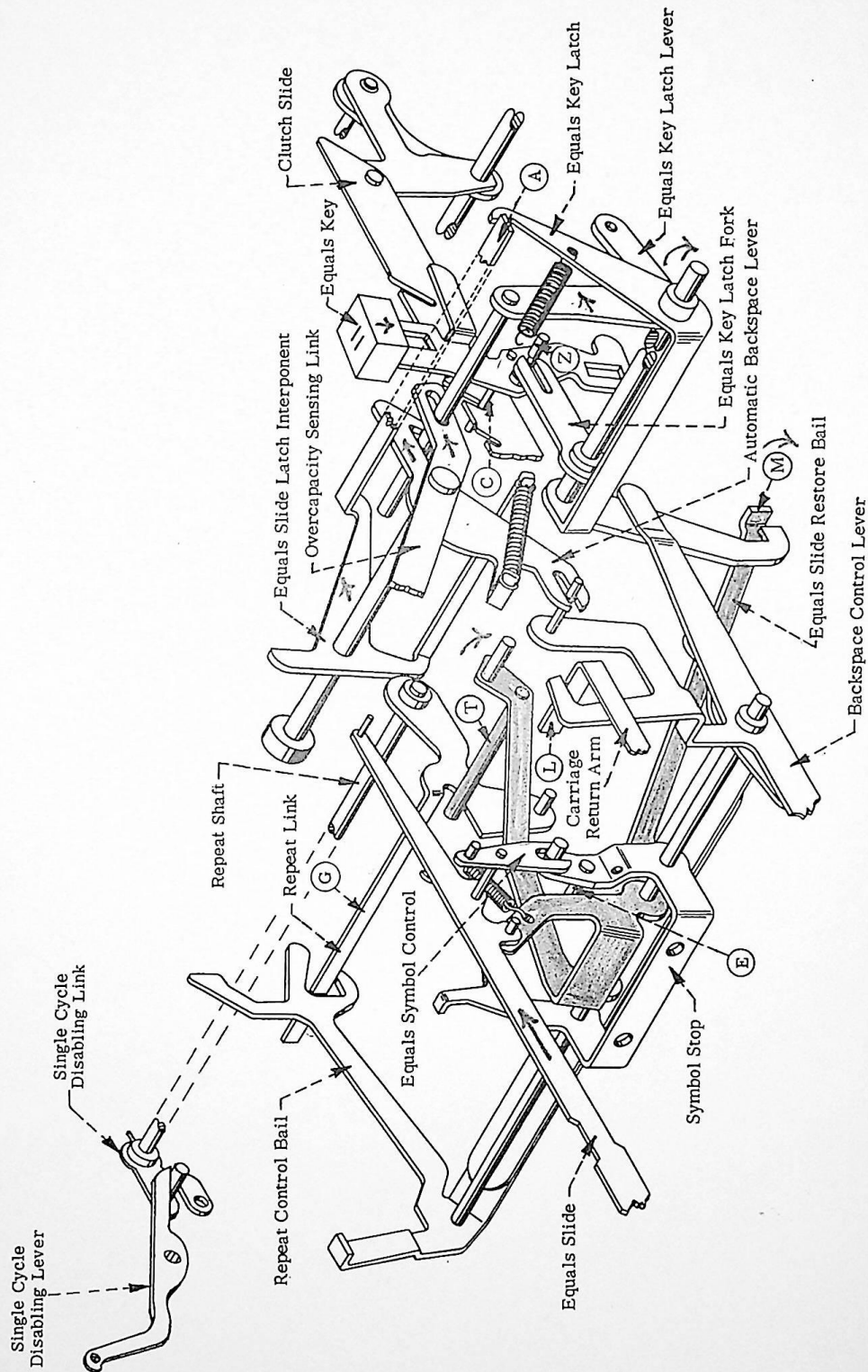
FRIDEN PRINTING CALCULATOR

OPERATIONS - Multiplication



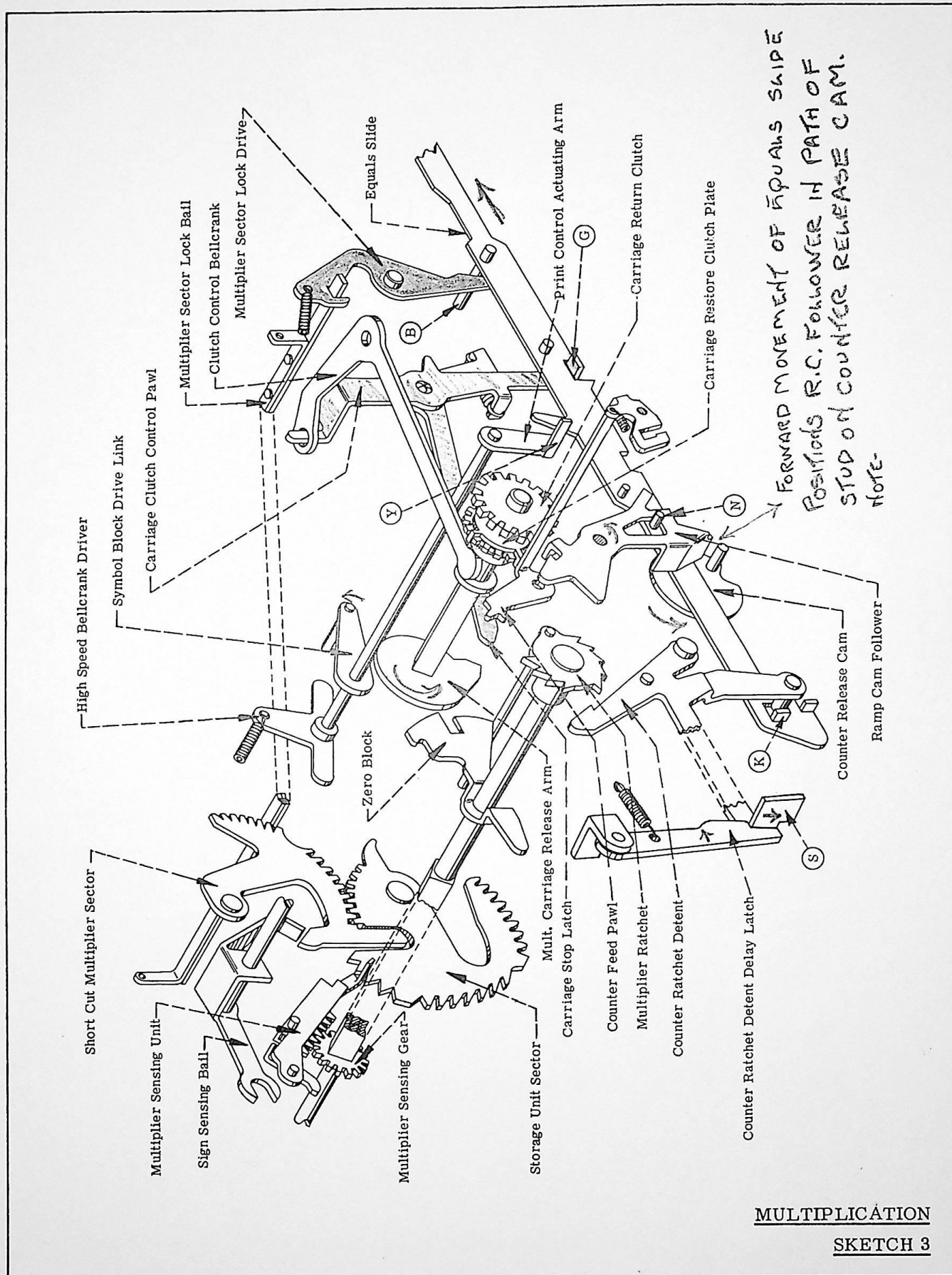
FRIDEN PRINTING CALCULATOR

OPERATIONS - Multiplication



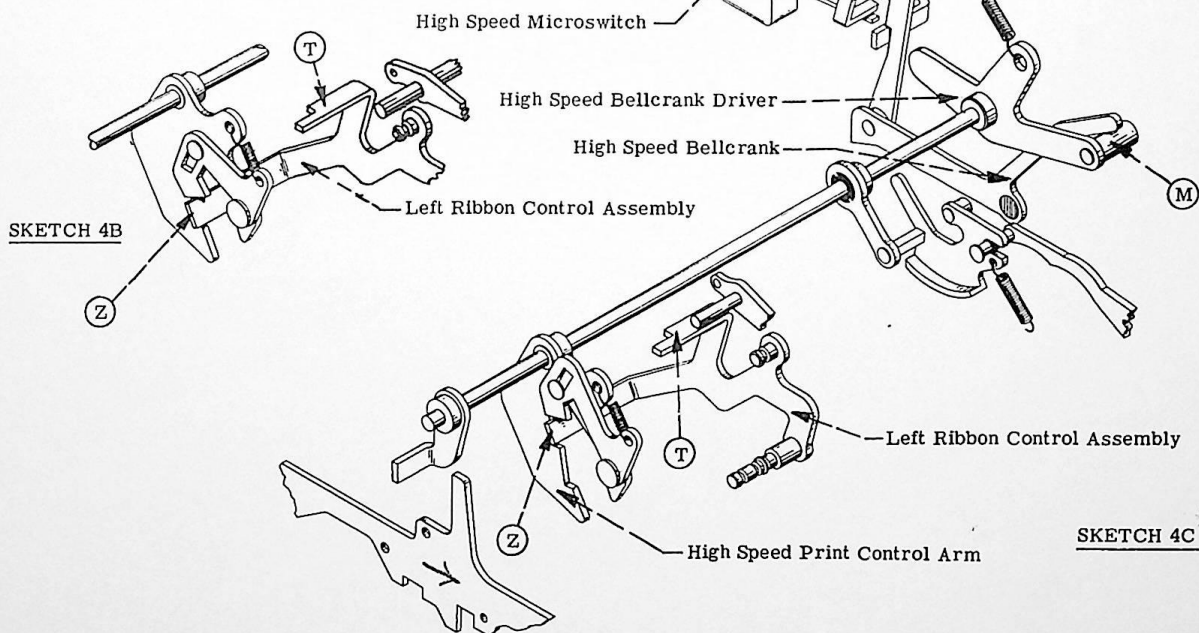
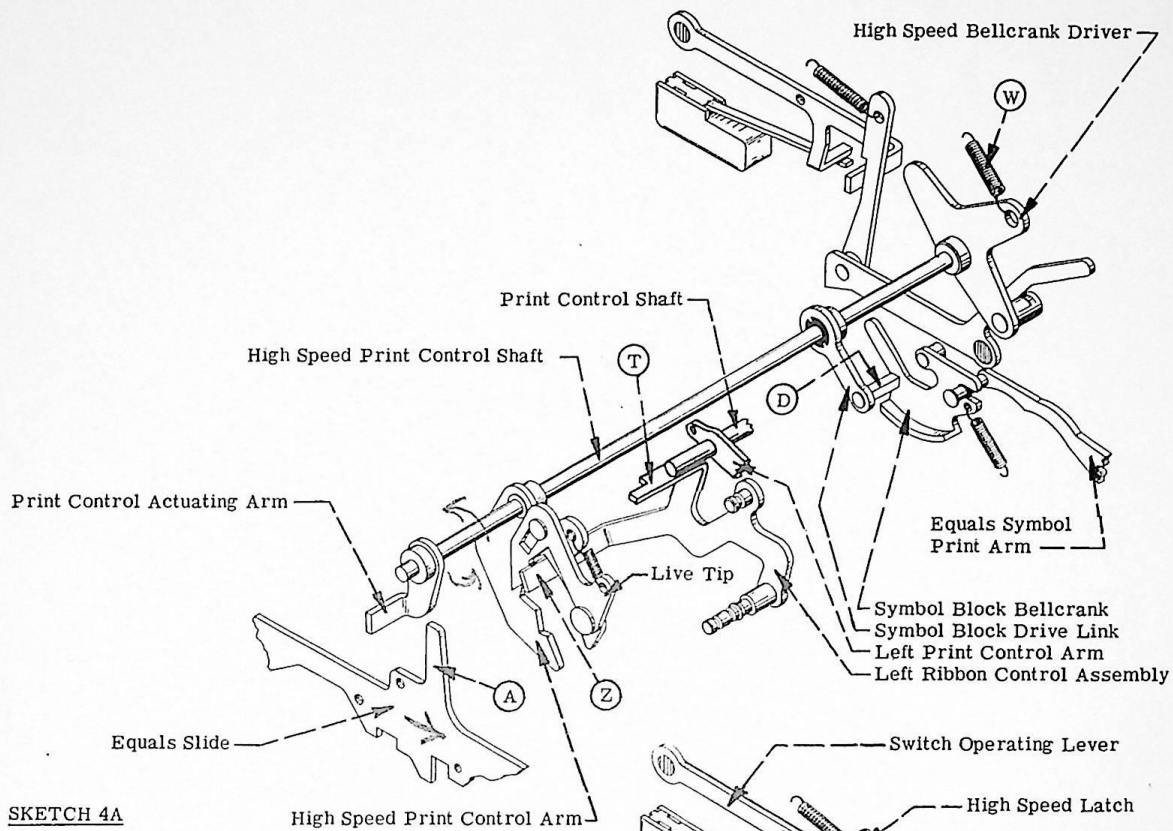
MULTIPLICATION

SKETCH 2



FRIDEN PRINTING CALCULATOR

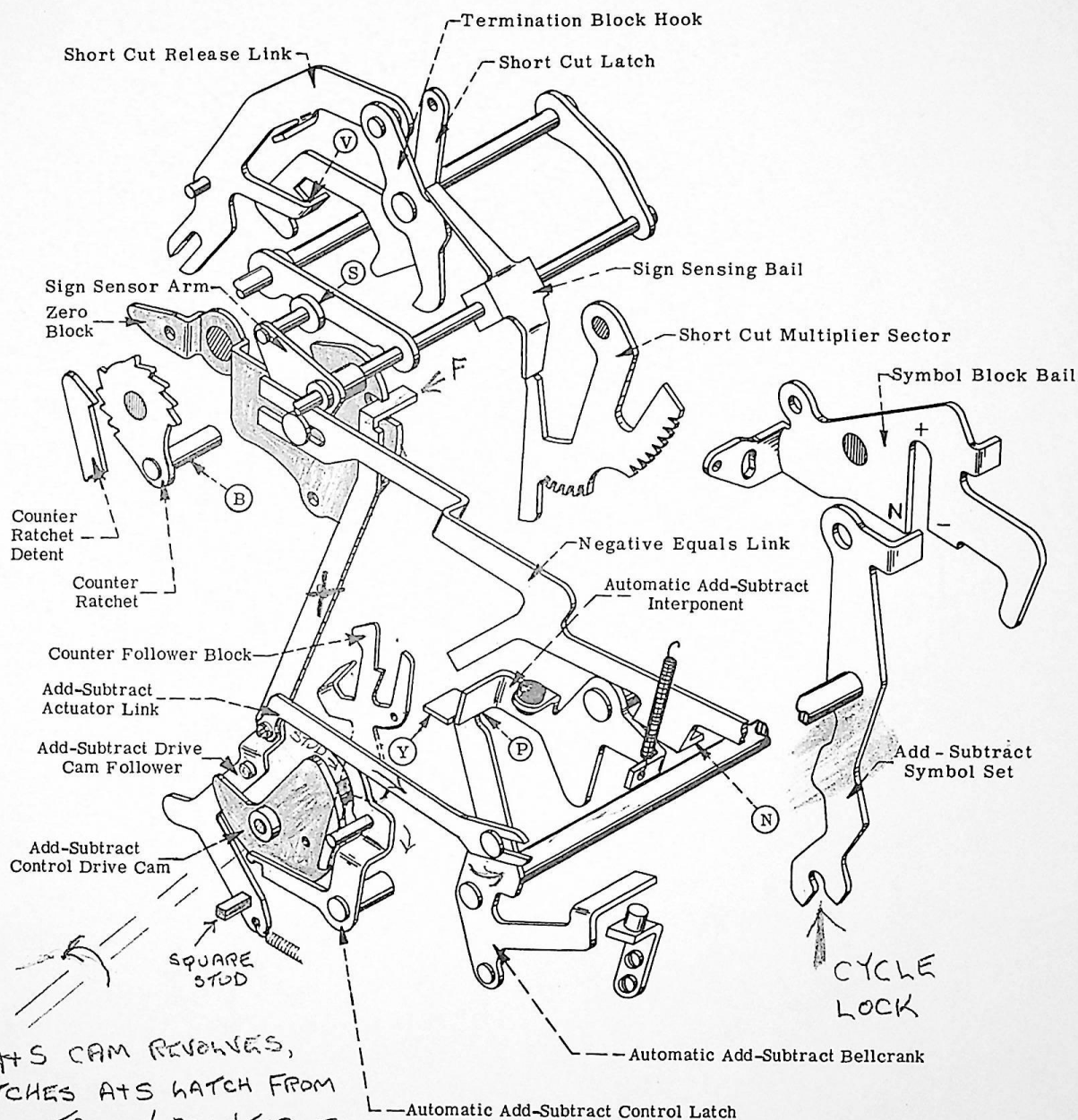
OPERATIONS - Multiplication



MULTIPLICATION

SKETCH 4

PARTS POSITIONED FOR REGULAR NUMBER

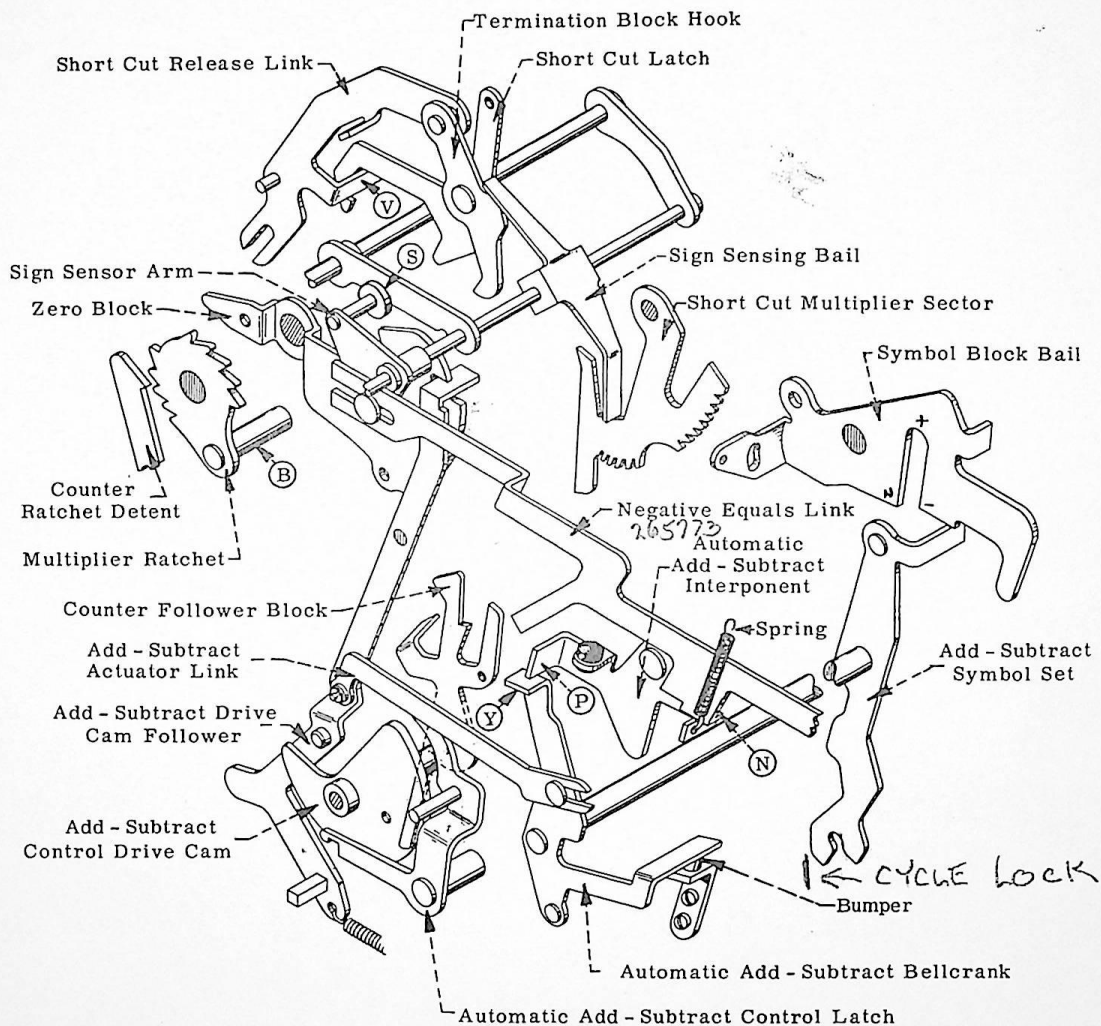


*1
 AT S CAM REVOLVES,
 STUD DETACHES AT S HATCH FROM
 SQUARE STUD. TAIL ON COUNTER FOLLOWER
 BLOCK HOLDS HATCH OFF OF SQUARE STUD
 FOR REMAINDER OF EQUALS OPERATION

MULTIPLICATION

SKETCH 5

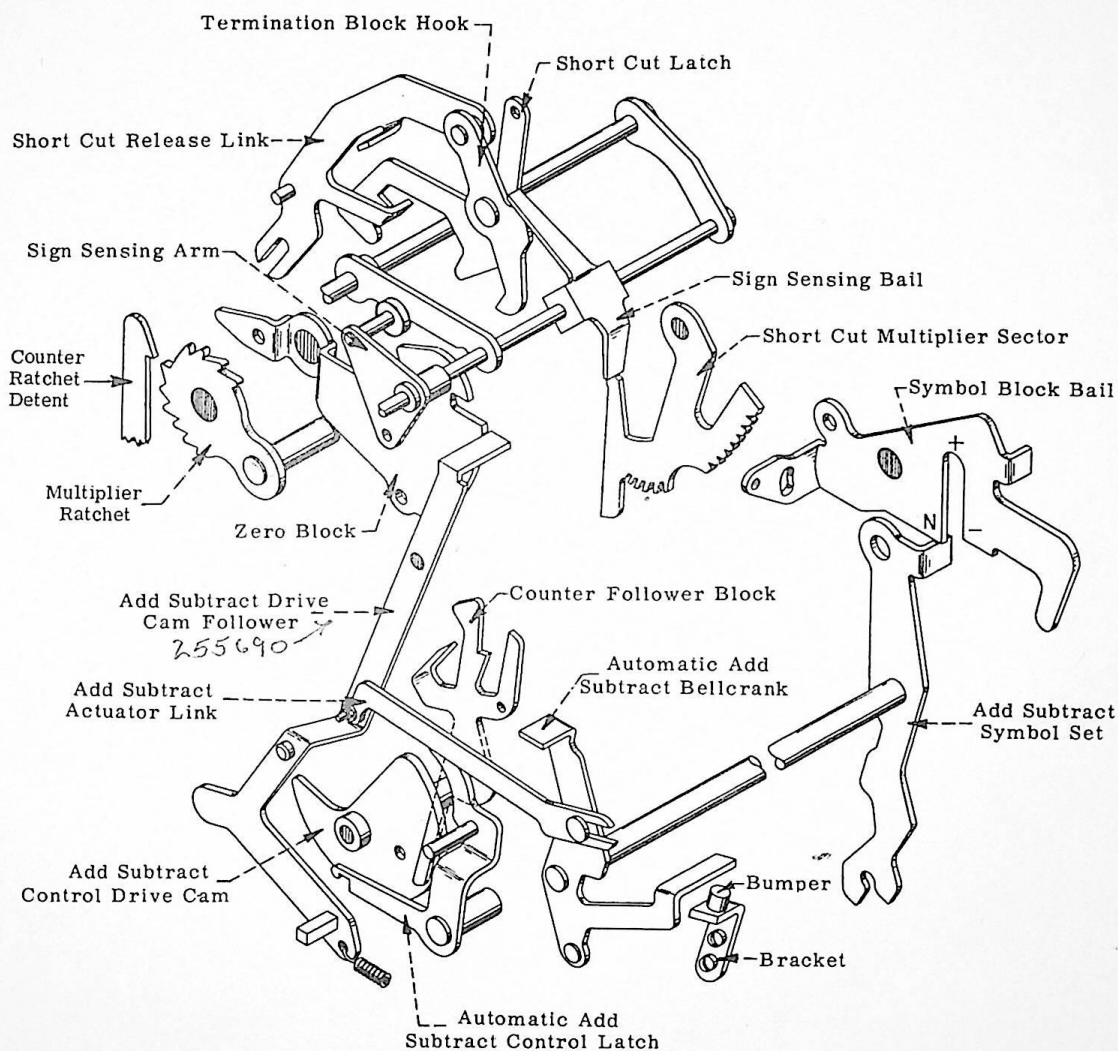
PARTS POSITIONED FOR SHORT CUT NUMBER.



MULTIPLICATION

SKETCH 6

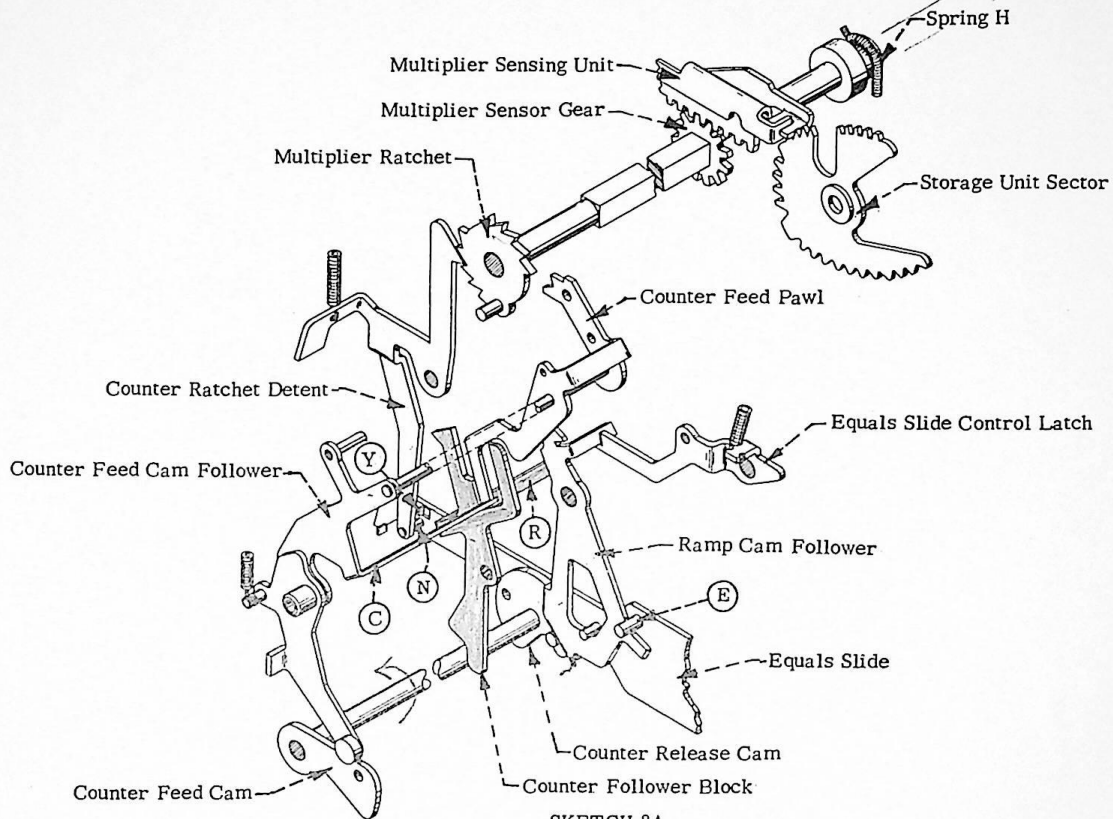
PARTS POSITIONED FOR ZERO.



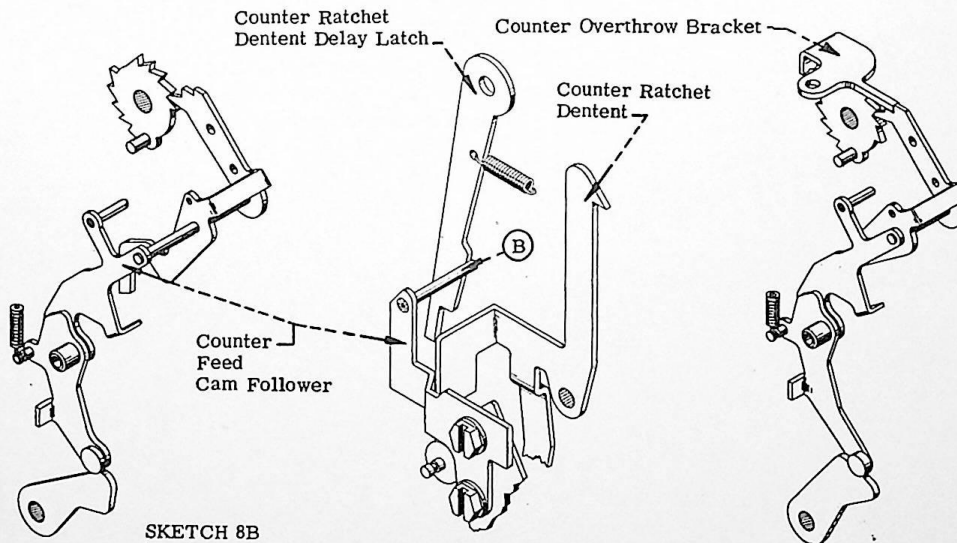
MULTIPLICATION

SKETCH 7

1. EQUALS SLIDE MOVES FORWARD
2. MOVEMENT OF RAMP CAM FOLLOWER CONTACTING STUD E RAISES EQUALS SLIDE
3. COUNTER RATCHET DETENT IS RELEASED (STUD N) BUT REMAINS OUT BECAUSE DETENT DELAY HAS LATCHED IT.



SKETCH 8A



SKETCH 8B

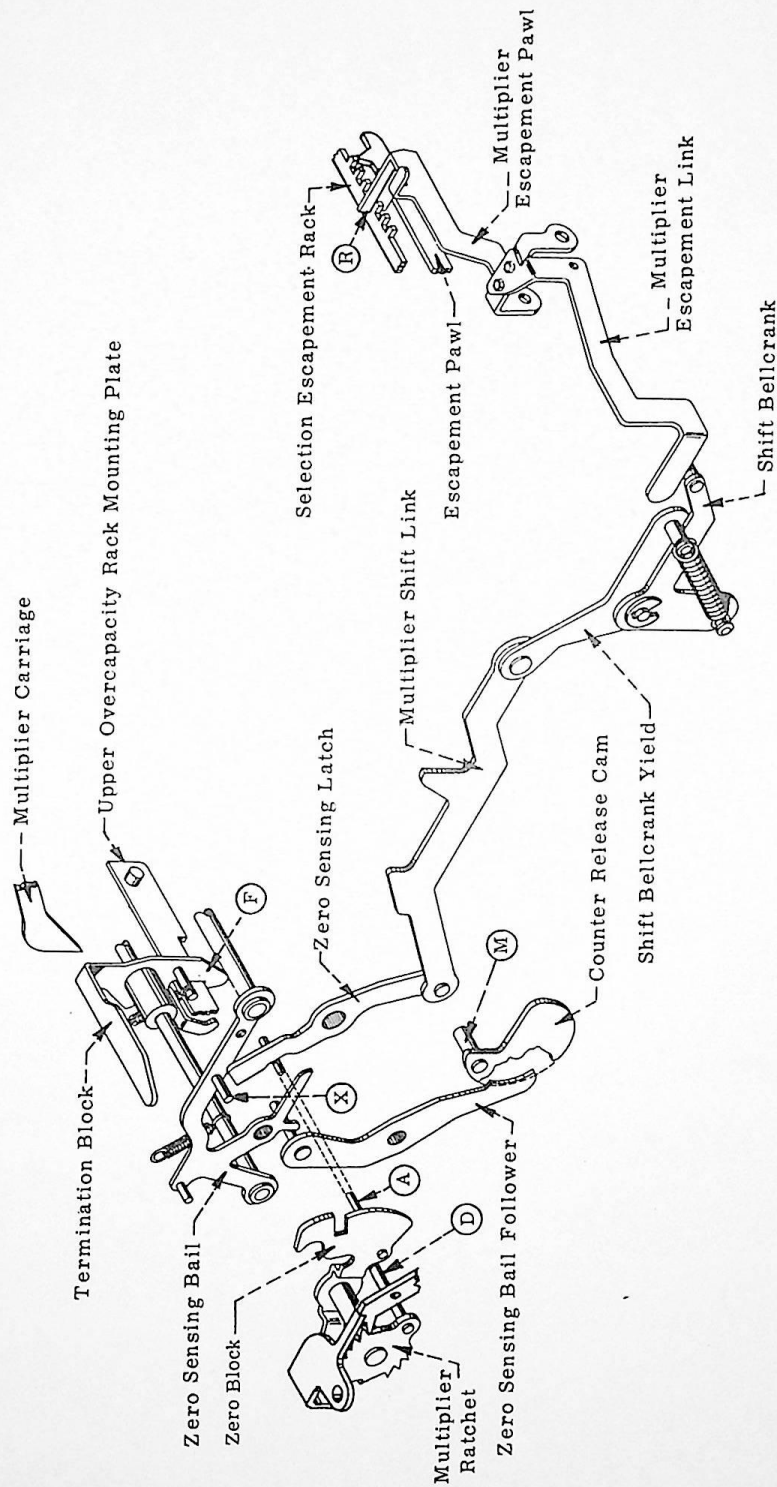
SKETCH 8C

SKETCH 8D

MULTIPLICATIONSKETCH 8

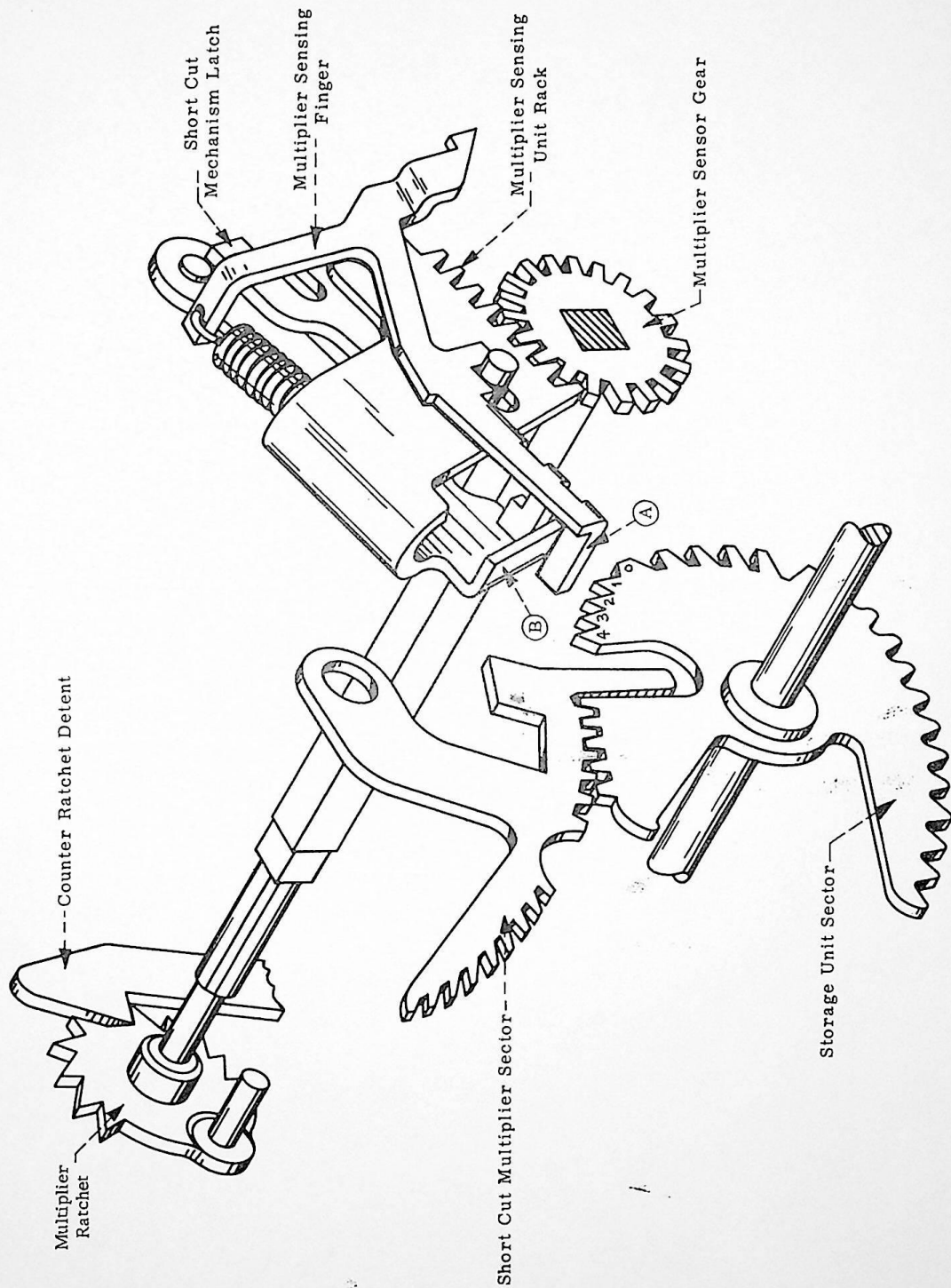
FRIDEN PRINTING CALCULATOR

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MULTIPLICATIONSKETCH 9

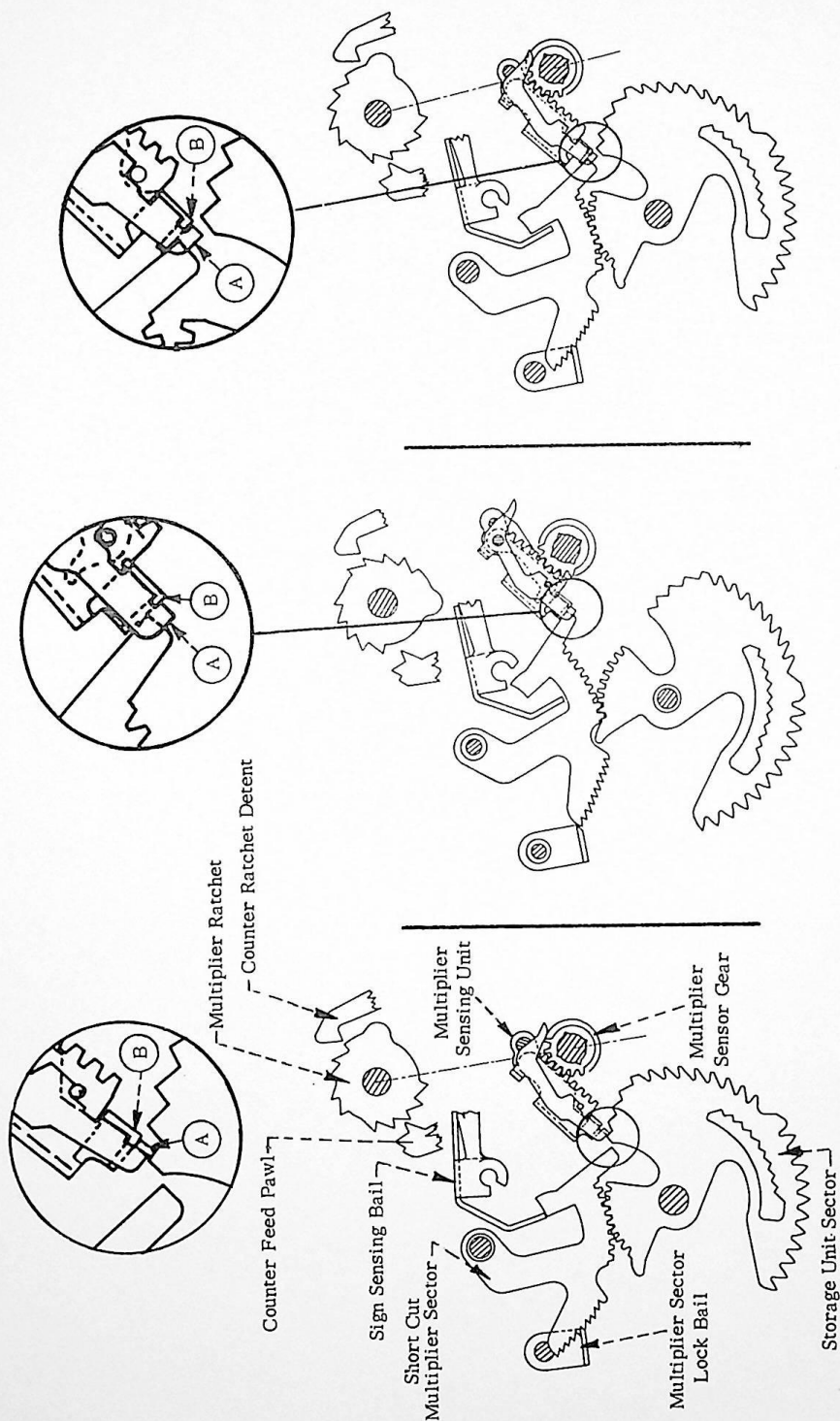
FRIDEN PRINTING CALCULATOR

OPERATIONS - Multiplication



MULTIPLICATION

SKETCH 11A



"5"
SKETCH 11B (3)

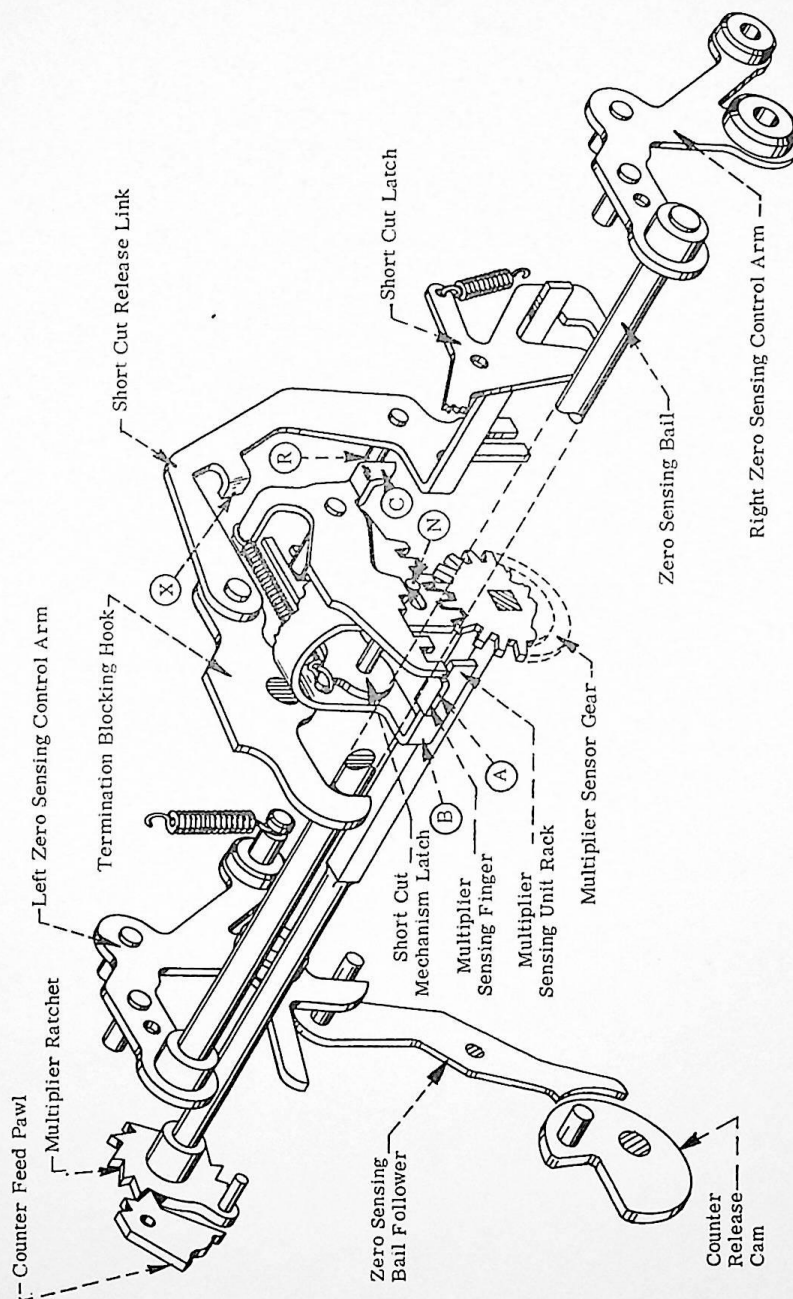
"9"
SKETCH 11B (2)

"4"
SKETCH 11B (1)

MULTIPLICATION
SKETCH 11B

FRIDEN PRINTING CALCULATOR

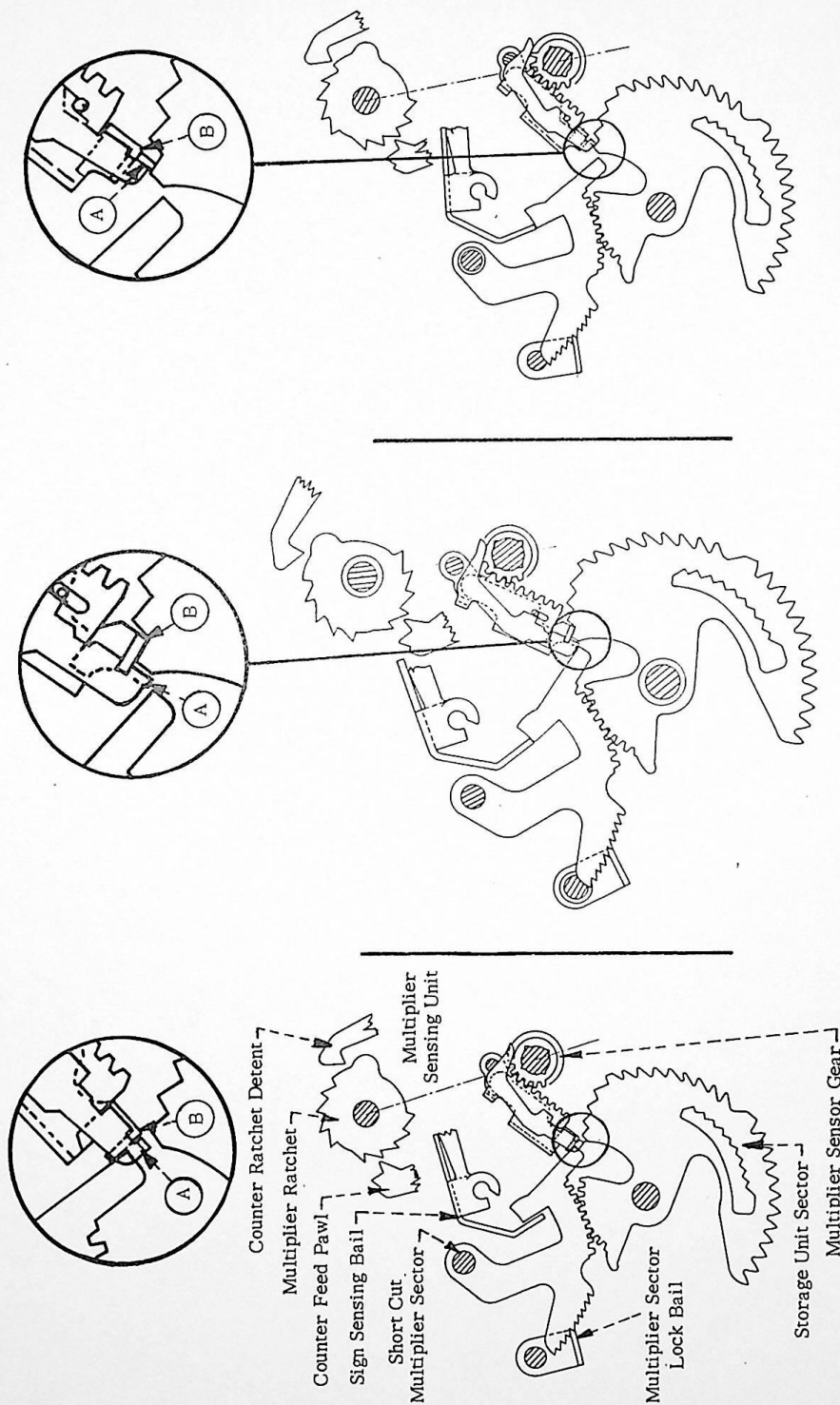
OPERATIONS - Multiplication



MULTIPLICATION
SKETCH 12A

FRIDEN PRINTING CALCULATOR

OPERATIONS - Multiplication



“4”
SKETCH 12B (3)

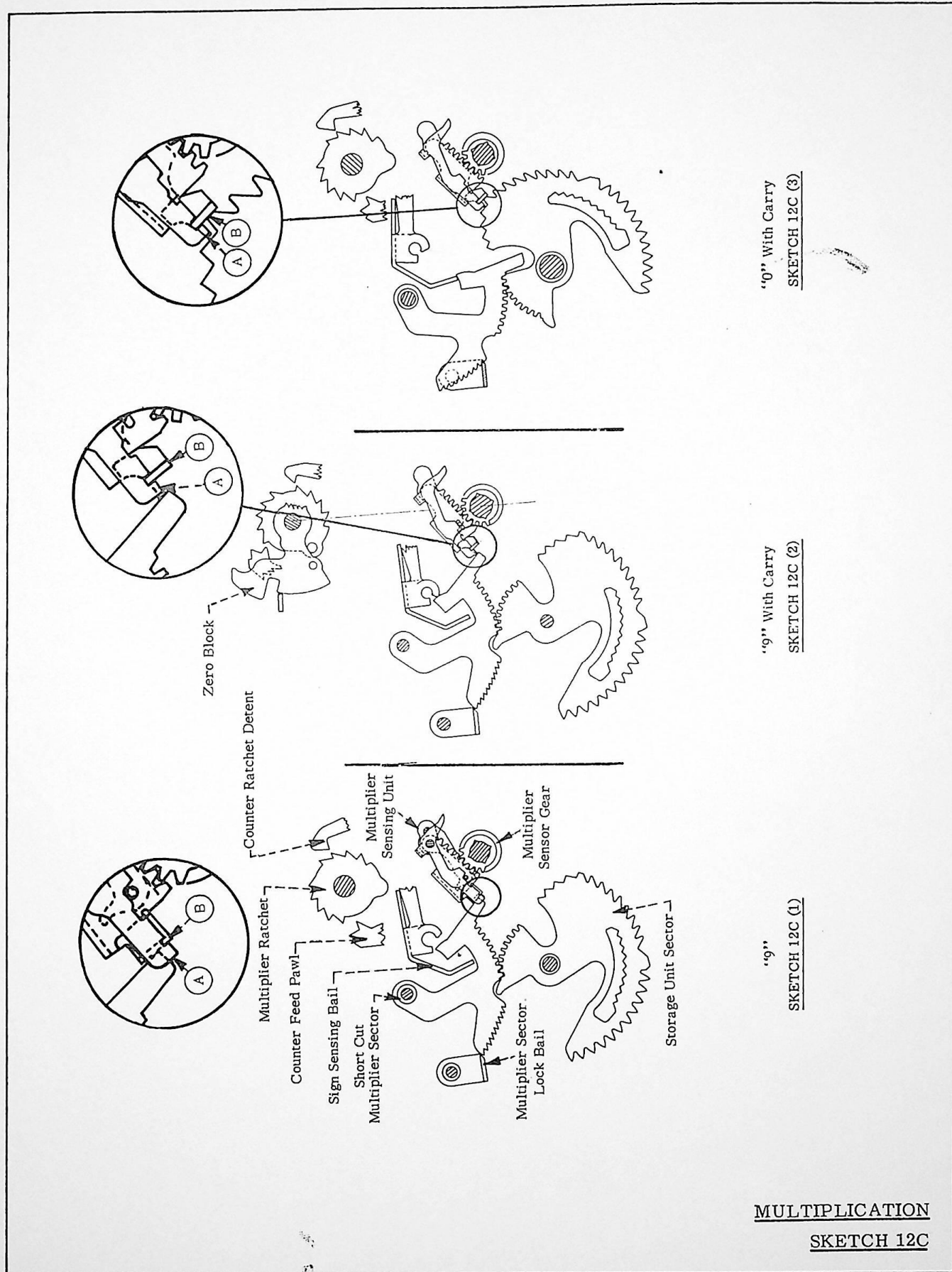
“4” With Carry
SKETCH 12B (2)

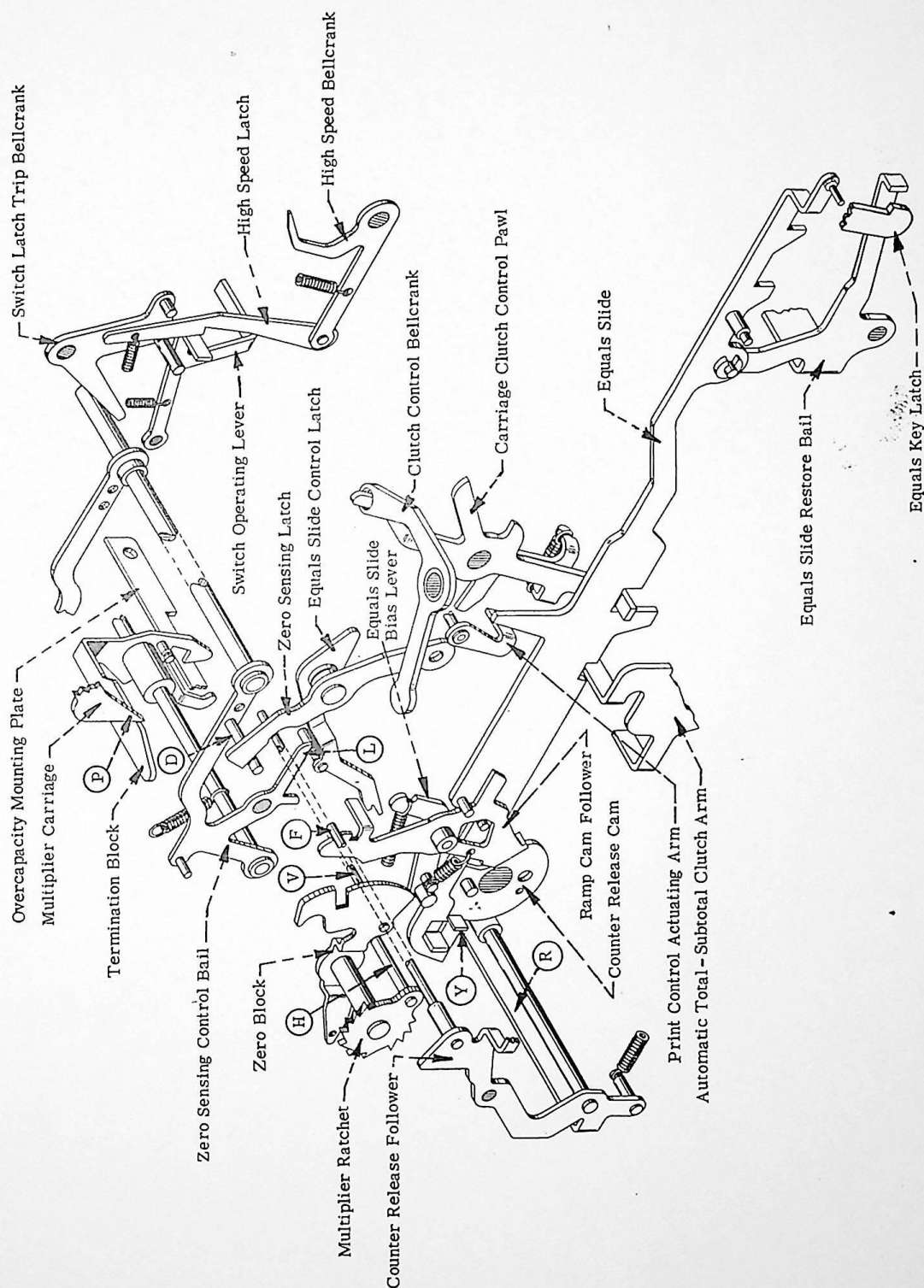
"5"
SKETCH 12B (1)

MULTIPLICATION
SKETCH 12B

FRIDEN PRINTING CALCULATOR

OPERATIONS - Multiplication



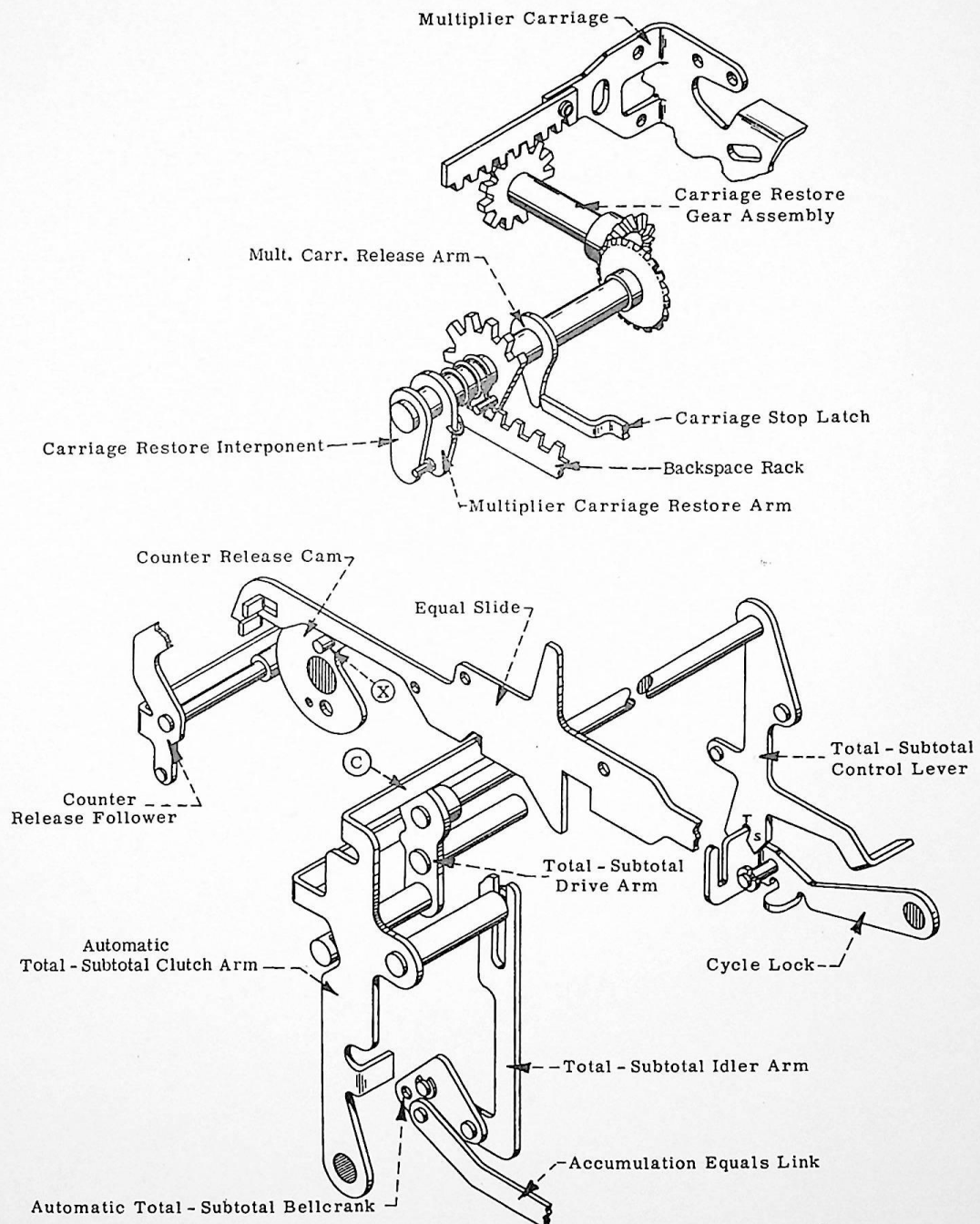


MULTIPLICATION

SKETCH 13

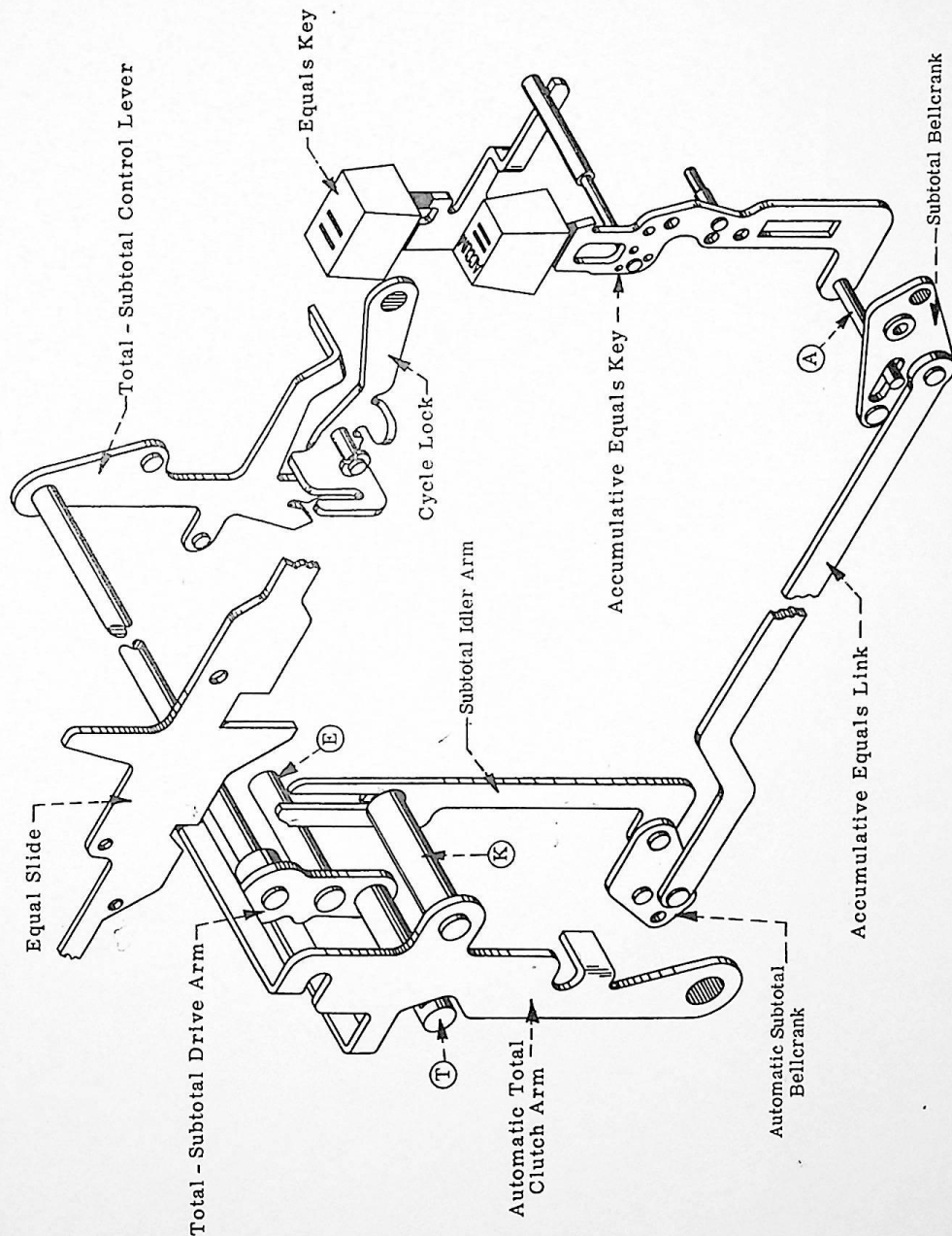
FRIDEN PRINTING CALCULATOR

OPERATIONS - Multiplication

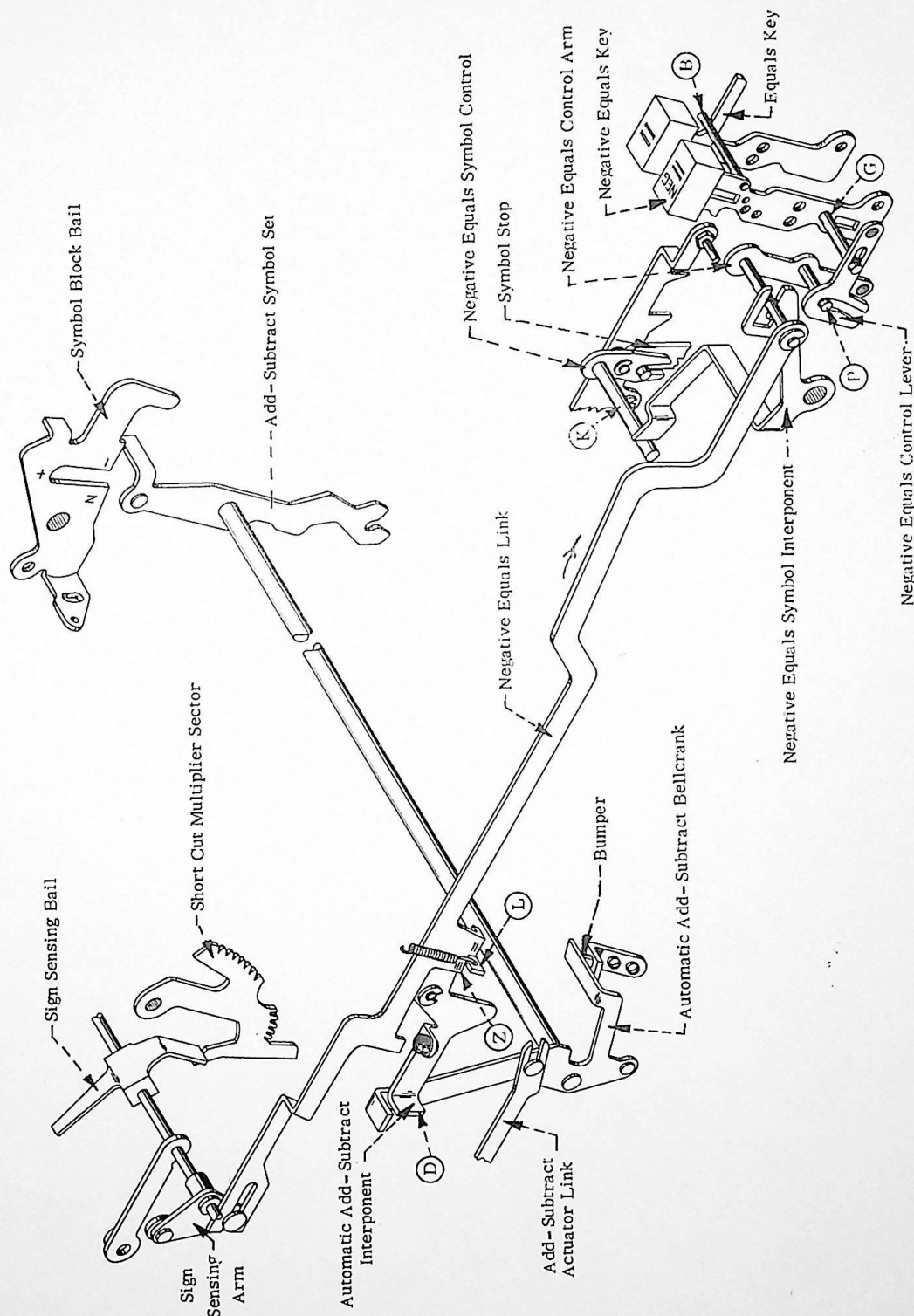
MULTIPLICATIONSKETCH 14

FRIDEN PRINTING CALCULATOR

OPERATIONS - Multiplication

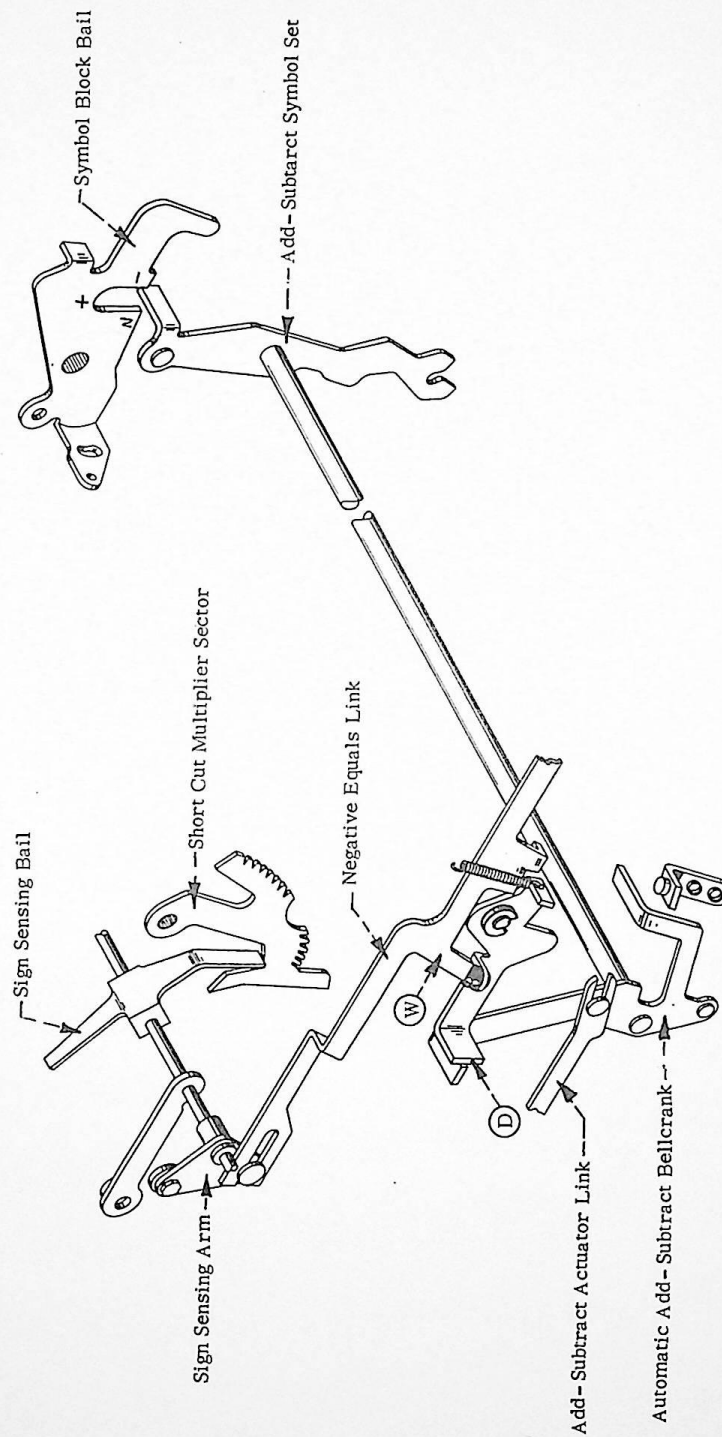


MULTIPLICATION
SKETCH 15

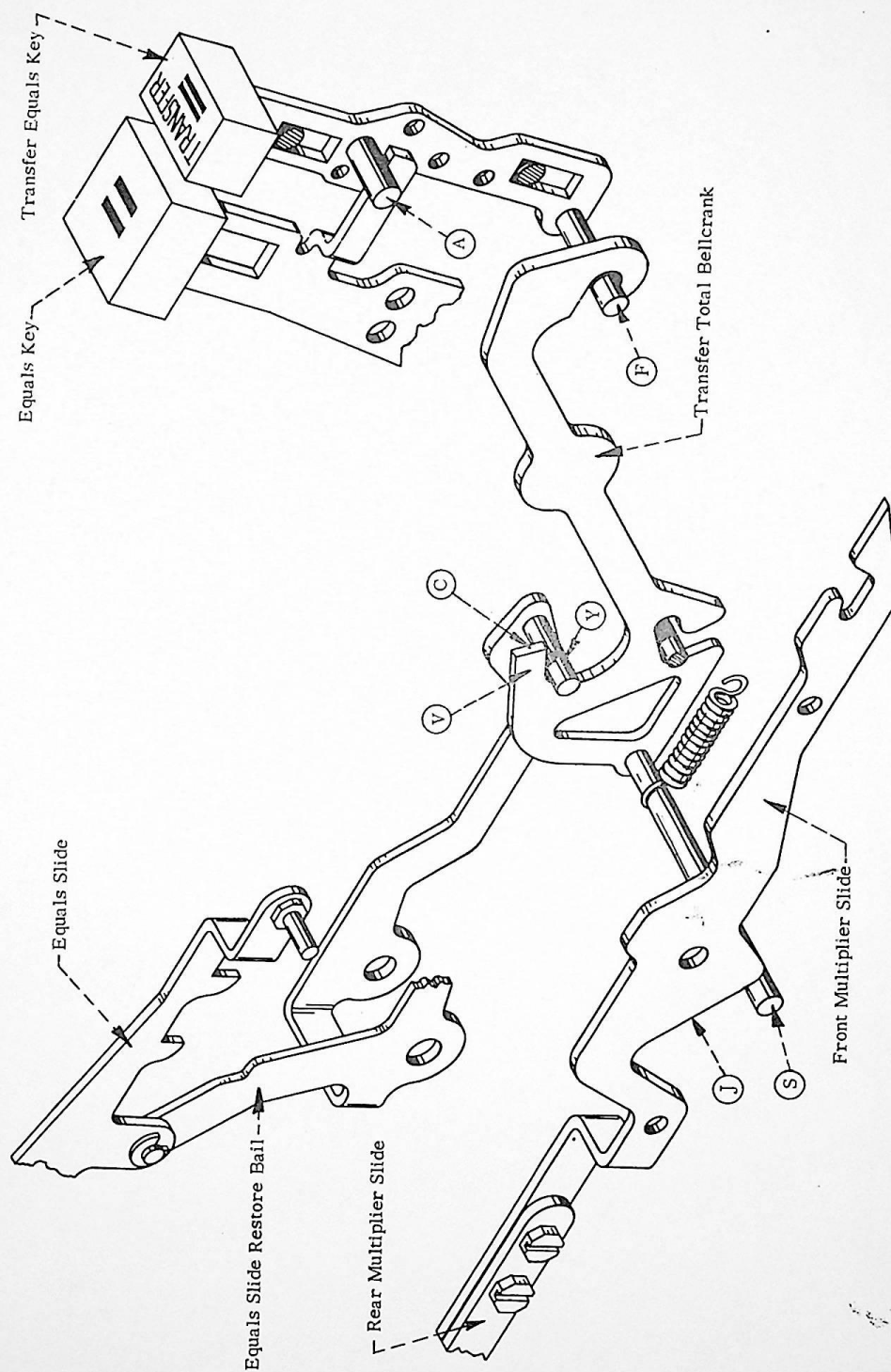


MULTIPLICATION
SKETCH 16A

FRIDEN PRINTING CALCULATOR
OPERATIONS - Multiplication



MULTIPLICATION
SKETCH 16B

MULTIPLICATIONSKETCH 17

INTRODUCTION

Division is performed on the printing calculator by a series of subtraction operations done automatically at the higher motor speed. The divisor, the dividend, and the quotient are printed on the tape. Printing is suppressed during the rest of a division operation.

The dividend is usually entered by means of the Enter Dividend key. This key causes the selection carriage to shift to the left so the first, or leftmost, digit is entered into the sixteenth order of the accumulator. Starting in the sixteenth allows the problem to be carried to a sufficient number of places to insure an accurate answer. The dividend could be entered by the Add key or any other key, or combination of keys, which would cause a positive amount to be entered into the accumulator. The machine will automatically line up the divisor with the dividend.

Next the divisor is entered into the carriage and the Division key depressed. This causes the carriage to shift either to the extreme left, or to some intermediate position to line up with the dividend. The machine then begins subtracting the divisor in the carriage from the dividend in the accumulator until an overdraft occurs, that is when the accumulator changes from a positive to a negative condition. The machine then makes a plus operation to correct the overdraft and shifts one order to the right. The machine will repeat these operations in each order until there is a zero remainder in the accumulator or if the divisor and the dividend are not evenly divisible until the carriage shifts all the way back to the right side. The division operation can also be terminated in any order by the Division Stop key.

A typical division problem would proceed as follows, using 851 divided by 37 ($851 \div 37 = 23$).

The dividend "851" is entered into the keyboard and the Enter Dividend key is depressed. This will cause the carriage to shift to the extreme left and the machine to begin a plus operation. The dividend will be printed on the tape as "85,100,000,000,000.00+" and entered into the accumulator in the sixteenth, fifteenth and fourteenth orders. The carriage is cleared and restored.

Next the divisor is entered into the keyboard and the Division ($\div$) key is depressed. This will cause the divisor to be printed on the tape as 37# ; and the carriage shifted to the left to line up with the first digit of the dividend, in this example the carriage is shifted to its extreme left position.

The division operation is controlled by the division program clutch. This clutch is driven by the rear drive shaft through a 4 to 1 gear reduction, so that it takes at least 4 main drive shaft, or machine cycles to cause one complete rotation of the division program clutch. The division operation is divided into four parts, or quadrants, by the division clutch.

During the first quadrant the divisor is printed and the selection carriage shifted to the left to line up with the first digit of the dividend.

During the second quadrant the machine is tested for overcapacity, or for a negative condition in the accumulator. Under either of these conditions the machine will not provide a correct answer. If the dividend is over the capacity of the machine or if the accumulator is in a negative condition the program will continue through the third and fourth quadrant printing out a ".00# -" for the quotient.

If the accumulator is in proper condition the division program clutch is stopped at the end of the second quadrant and the controls are set to begin the digitation, or counting, cycles. Counting finger is set to record the number of subtraction cycles in the storage unit sectors. In this example the machine makes three subtract cycles in the first, or leftmost, order. The last subtract cycle causes an overdraft, or causes the accumulator to go negative, then the machine will make a plus cycle to restore the overdraft. The machine does not count the first minus cycle or the plus cycle so there will be two counts recorded in the first storage unit sector. Then the carriage and the counting finger will be shifted one order to the right and the subtract operations begin again. In the second order the machine will make four minus cycles to cause an overdraft, then one plus cycle, which will cause three counts to be recorded in the second storage unit sector. Since the figures in this example are evenly divisible this last plus cycle did not restore the accumulator to a positive condition, but only to a negative zero, and the controls are not reset for subtraction. In this case the machine attempts to make another plus cycle but the controls set on the first plus cycle prevent any accumulator entry.

This second, attempted, plus cycle re-starts the division program clutch to begin the termination operations which consists of printing the quotient by reading out the memory unit during the third quadrant and reading the remainder out of the accumulator during the fourth quadrant. In this example there was no remainder because the figures were evenly divisible.

To illustrate what the division mechanism does automatically this example could be worked using the minus and plus key and checking the figure in the accumulator at each step, as the machine does by means of the audit balance indicator, in

which case it would appear on the tape as shown below.

On the following pages a more detailed explanation of the division mechanism is given.

8 5,1 0 0,0 0 0,0 0 0,0 0 0,0 0 +	Enter dividend into accumulator		
3 7,0 0 0,0 0 0,0 0 0,0 0 0,0 0 -	Subtract divisor	-	-
4 8,1 0 0,0 0 0,0 0 0,0 0 0,0 0 S	Check accumulator		
3 7,0 0 0,0 0 0,0 0 0,0 0 0,0 0 -	Subtract divisor		
1 1,1 0 0,0 0 0,0 0 0,0 0 0,0 0 S	Check accumulator	1	-
3 7,0 0 0,0 0 0,0 0 0,0 0 0,0 0 -	Subtract divisor		
2 5,9 0 0,0 0 0,0 0 0,0 0 0,0 0 S	Check accumulator - Overdraft	1	-
3 7,0 0 0,0 0 0,0 0 0,0 0 0,0 0 +	Add divisor to correct overdraft		
1 1,1 0 0,0 0 0,0 0 0,0 0 0,0 0 S	Check accumulator		-
	Shift carriage		
3,7 0 0,0 0 0,0 0 0,0 0 0,0 0 -	Subtract divisor		
7,4 0 0,0 0 0,0 0 0,0 0 0,0 0 S	Check accumulator		
3,7 0 0,0 0 0,0 0 0,0 0 0,0 0 -	Subtract divisor	-	1
3,7 0 0,0 0 0,0 0 0,0 0 0,0 0 S	Check accumulator		
3,7 0 0,0 0 0,0 0 0,0 0 0,0 0 -	Subtract divisor	-	1
.0 0 S	Check accumulator		
3,7 0 0,0 0 0,0 0 0,0 0 0,0 0 -	Subtract divisor	-	1
3,7 0 0,0 0 0,0 0 0,0 0 0,0 0 S	Check accumulator - Overdraft		
3,7 0 0,0 0 0,0 0 0,0 0 0,0 0 +	Add divisor to correct overdraft		
.0 0 S	No remainder		
If all subtract cycles except the first in each order are counted the result will be the quotient, in this case "23".		2	3

ENTER DIVIDEND - Sketch 1

Full depression of the Enter Dividend key allows ear A of the spring loaded Dividend key latch to drop over the shoulder on the key stem to hold the key down. The spring loaded key latch live-tip swings forward under nose N of the enter dividend clutch control fork. The enter dividend shift lever is rotated counterclockwise to rock the escapement pawl out of engagement with the selection unit escapement rack. This allows the carriage to escape all the way to the left.

As the carriage reaches its leftmost position, it strikes nose T of the Division key latch and rocks ear A to the left so the Enter Dividend key can move upward under spring tension.

As the Enter Dividend key moves up, the key latch live-tip rocks stud Z of the enter dividend clutch control fork into the slot in the clutch

throwout slide, camming it forward to start the motor and engage the main clutch. The lower arm of the enter dividend clutch control fork pushes the enter dividend control link rearward, which in turn pushes the dividend slide against stud D to rock the automatic add-subtract bell-crank clockwise to set the controls for a plus operation.

The dividend is now entered into the accumulator and printed on the tape as described under "Add Cycle"; except, that since the carriage has been shifted to its leftmost position, the figures are printed on the left side of the tape and entered at the left side of the accumulator starting from the sixteenth order. This is to provide for carrying the division to a sufficient number of decimal places.

DIVISION KEY - Sketch 2

Depression of the Division key causes stud W on the Division key control latch to rock the division slide latch, lifting stud H out of engagement with the division slide pivot arm, allowing the division slide to move forward under the tension of the spring. The rear division slide is also pulled forward, rocking the division clutch pawl (Sketch 3) out of engagement with the division program shaft clutch.

The forward movement of the division slide rocks the lower arm of the division slide pivot arm down against the stud on the repeat link, (Sketch 2) rocking it counterclockwise. The rocking of the repeat link disables the single cycle through the single cycle disabling lever which is pinned to the other end of the shaft. The ear on the repeat link rocks the repeat control lever down, which sets the backspace control lever and the repeat bails for repeat operation as explained under "Repeat Add". Stud V, on the Division key, rocks the symbol sector stop to place ear R in position to engage the second notch in the symbol sector so a division symbol will be printed on the tape.

Stud B on the Division key engages the slot in the left clutch throwout slide, camming it forward, to rock the clutch throwout shaft to engage the main clutch and start the motor.

CLUTCH OPENING - Sketch 3

As the rear division slide is pulled forward by depression of the Division key, Sketch 2, it rocks the division clutch pawl out of engagement with the division program clutch, Sketch 3, allowing the clutch pawl to engage the ratchet. The division program shaft is driven by a gear on the rear drive shaft at one-fourth the speed of the main and rear drive shafts. In other words, the division program shaft makes one-fourth turn for each revolution of the main drive shaft.

Forward motion of the rear division slide, causes stud C to rock the division carriage clutch bellcrank, which in turn, rocks the carriage restore clutch plate into engagement with the prongs of the carriage return clutch locking the front and rear carriages together. The carriage clutch lever is rocked out of engagement with the keyboard release arm to allow the carriages to shift as soon as the selection carriage escapement pawl is moved out of the rack.

PRINTING DIVISOR - Sketch 4

At the beginning of a division operation, the divisor is printed on the tape. This printing operation is

initiated by starting the motor and engaging the main clutch on depression of the Division key. If no other controls are set, the machine will automatically print the figure in the selection unit as described under "Non-Add". However, since the repeat controls have been set previously, the carriage cannot be cleared or restored.

As the division program shaft starts to turn, Sketch 4, the high speed print block cam allows the high speed print control cam follower to rock rearward slightly. This rocks the high speed print control arm downward, through stud R, far enough to move stud B out of the path of the symbol block bellcrank. Depression of the Division key sets the symbol sector stop, Sketch 2, to stop the symbol sector for a division sign which will be printed on the tape with the divisor.

DIVISOR LINE-UP - Sketches 5 & 6

The first figure of the dividend will be in the sixteenth order of the accumulator if it was entered with the Enter Dividend key. However, at times the dividend might be the result of a series of additions, as when taking an average. In this case, if the machine started in the sixteenth order, it would have to perform several unnecessary division operations before reaching the first significant figure of the dividend. To avoid these unnecessary operations, early in the division cycle the accumulator is tested for zeros and the selection carriage is aligned with the first significant figure of the dividend.

In each order of the accumulator, except the first, there is an accumulator sensor (Sketch 5) attached to the upper end of a sensor arm. The sensor arms are attached by springs to the sensor arm bail. As the division program clutch begins to turn, the clutch disc rocks the division sensing cam follower counterclockwise, pulling the division line-up link forward and rocking the division line-up shaft assembly clockwise. As the division line-up shaft is rocked clockwise, the sensor arm bail, which is pinned to the shaft, is rocked forward. Through the springs, the bail pulls the sensor arms and the accumulator sensors in toward the accumulator gears. In each accumulator gear there are two round notches. When the gears are in a positive zero condition, the notches will be in a position for the accumulator sensors to enter. When there is a figure other than a positive zero in the gear, the accumulator sensor will be blocked out.

Each sensor arm has an ear which overlaps the arm to the left. If the accumulator sensor in one order is held out, all sensor arms to the right will also be held out by the overlapping ears.

The accumulator sensors to the left of the first digit of the dividend can enter the notch in the gear and the sensor arms rock farther forward. After the divisor has been printed on the tape, the division program cam allows the division slide to be pulled forward by the spring. The forward motion of the division slide (Sketch 6) pushes the tip of the division escapement release bellcrank against the tail of the escapement pawl, moving the point out of the selection unit escapement rack, allowing the selection unit to move to the left.

As the selection carriage moves to the left, the selection carriage rack causes the idler gears (Sketch 5) to drive the selection carriage return rack and the backspace rack forward. The backspace rack drives the carriage return clutch gear, and through the carriage return clutch and the bevel gear, moves the multiplier carriage to the same order as the selection carriage. This positions the division counter tooth for counting in the proper order. The overcapacity gear sector is in mesh with the gear on the carriage return clutch and as that gear rotates the overcapacity gear sector is rocked up. As the overcapacity gear sector rocks up, the overcapacity sensor gear, the intermediate gear, and the idler gear are rotated. The idler gear moves the overcapacity rack and the division aligner arm to the same order as the selection carriage.

Since the selection carriage, the multiplier carriage, and the division aligner arm are all tied together by the gear train shown in Sketch 5, they must move together. If the first figure of the divisor is in the sixteenth order, the carriages will be allowed to move all the way to the left and the division aligner arm will stop against a bumper on the side frame. If the first figure of the divisor is not in the sixteenth order, the division aligner arm will stop against the top of the sensor arm in the order immediately to the left of the first figure of the divisor. The zero in this order allows the sensor arm to rock in further and govern the stopping point.

The escapement pawl is moved back in, to engage the selection carriage escapement comb at the end of the second quadrant of the division program shaft when the division program cam moves past point A (Sketch 6).

TEST ACCUMULATOR FOR OVERCAPACITY OR NEGATIVE CONDITION - Sketch 7

The machine cannot perform a division operation if the accumulator is in a negative condition or if there is a figure in the seventeenth order. At the beginning of the second quadrant of the division program shaft, or second main clutch cycle,

the machine tests the accumulator for these conditions.

The sensor arm bail was previously rocked forward to pull the sensor arms in to test the accumulator for the location of the dividend. The sensor arm bail is now rocked in further by the division line-up link (Sketch 7) and the division sensing cam follower following the clutch disc. The 17th order accumulator sensor is shorter than the other ones, so it is not rocked all the way in on the first testing of the accumulator. Rocking the sensor arm bail now pulls the 17th order accumulator sensor into the accumulator gear while the springs pulling the other orders in yield. If there is a positive zero in the 17th order accumulator gear the sensor can enter the notch. If the accumulator is in a negative condition, the credit balance indicator extension will rock stud H into a position to block the 17th order accumulator sensor.

If the 17th order accumulator sensor is blocked, either by the gear being out of a positive zero position, or by stud H, the sensor arm bail is rocked forward, the rear 17th order termination link is pivoted clockwise about stud B rocking stud T toward the rear of the machine. If the forward travel of the sensor arm in the seventeenth order is blocked, stud B will also be held in a rearward position and stud T will be rocked to its extreme rearward position. When stud T is rocked to its rearward position it engages the hook of the 17th order termination link and pulls it rearward rocking the division termination latch up so it cannot engage ear W. If the sensor arm can move into the seventeenth order, stud B will be held forward and stud T will not be pivoted as far to the rear and will not move the 17th order termination link far enough to disable the division termination latch.

As the division program shaft reaches the end of the second quadrant, or second main clutch cycle, point E on the division latch cam rocks the division latch cam follower down. The arm of the division termination latch normally overlies ear W of the division latch cam follower and latches it when it is rocked down. If the 17th order termination link is pulled rearward by stud T the division termination latch will be held up and cannot latch ear W.

When the division latch cam follower is rocked down, the division restore clutch control is rocked in to stop the division program shaft clutch. If ear W can be latched by the division termination latch, the division program shaft will be stopped and the machine will begin the counting operations. If ear W cannot be latched because of an

overcapacity or negative condition in the accumulator, the division restore clutch control will be rocked out again by the spring and the division program shaft will continue through the third and fourth quadrants to terminate the division operation by printing zero for a quotient.

CLEARING THE MEMORY UNIT - Sketch 8

The memory unit must be clear before the quotient can be entered into it. During the second quadrant of the division program shaft, a memory clearing operation takes place.

During the second quadrant of the division program shaft rotation, the lifter bail latch blocking cam is rotated into a position to hold stud A forward as shown in Sketch 8. This holds the lifter bail latch assembly in a position to block the ear on the lifter bail cam follower and prevents the lifter bail from raising the actuator pawls into engagement with the memory sectors as described under "From Memory" operation.

The readout latch control cam rocks the quotient bellcrank counterclockwise and stud M rocks the pendant block control arm to the rear. Rearward movement of the pendant block control arm rocks the multiplier restore control bellcrank counterclockwise and stud R raises the restore push link into position to intercept the stud on the actuator rocker gear sector. When the actuator rocker gear sector is driven down, the stud engages the lug on the restore push link and drives it to the rear, rocking the storage unit restore shaft assembly clockwise to clear the memory unit.

SUBTRACTING AND COUNTING - Sketch 9

If testing the accumulator, Sketch 6, indicates that the accumulator is positive and there is a zero in the seventeenth order, the division restore clutch control will be rocked in to stop the division program shaft clutch, and held in by the division termination latch engaging ear V. Rocking the division latch cam follower by the division latch cam, Sketch 6, also rocks the division latch live-point away from ear N of the division add-subtract follower permitting it to follow the division add-subtract cam.

When the accumulator is in a positive condition, the credit balance indicator extension is rocked forward, as shown in Sketch 9. This rocks the negative zero block and the division overstroke bellcrank clockwise. This swings the division add-subtract interponent into engagement with stud B on the automatic add-subtract lever. As the rear

drive shaft turns, ear D of the division add-subtract cam follower drops to the low of the division add-subtract cam. This causes the division add-subtract interponent to pull stud B upward to rock the automatic add-subtract lever and the add-subtract symbol set, which is pinned to the same shaft, clockwise to set the machine for a minus operation, as described under "Subtract Key". As the division restore clutch control is rocked in to stop the division program shaft clutch, the division bias blockout, which is pinned to the same shaft, is rocked counterclockwise to close the high speed microswitch. All counting operations are done at the higher motor speed.

As the division bias blockout is rocked down, it is also moved away from stud G allowing the bias bail latch and the bias pawl to move upward against the ear of the division bias bail. However, the bias bail latch does not engage the ear of the division bias bail early enough in the first minus cycle to allow a count, so the first subtraction from the accumulator is not counted because the extra minus cycle the machine must make to cause an overdraft is counted. Toward the end of the first minus cycle the division bias cam follower is rocked clockwise by the stud on the division bias cam. This causes the bias pawl to push the ear on the division bias bail forward far enough for the ear to be engaged by the bias bail latch. The bias bail will be held in place for counting each succeeding subtraction from the accumulator until released by a plus operation which will be explained later.

COUNTING - Sketch 10

The division bias bail was latched in at the end of the first minus cycle. This holds the counter tooth into the memory sector as shown in Sketch 10. The counter finger is lined up with the first figure of the dividend as explained under "Division Line-Up". Early in the second minus cycle, as the actuator rocker gear sector is rocked down, it pulls the division counter link forward rocking the division counter bail and the counter finger down, moving the memory sector one tooth. As the actuator rocker gear sector is rocked up, the division counter bail is restored, lifting the counter finger up and into engagement with the next tooth space.

The machine will continue subtracting the divisor from the dividend in the accumulator, counting each minus operation, until the accumulator is overdrafted, that is, it goes from a positive to a negative condition. This causes the credit balance indicator to be rocked, as explained under "Accumulator". This in turn rocks the credit

balance indicator extension which causes the controls to be positioned for a plus operation on the next machine cycle.

FIRST PLUS AND BACKSPACE CYCLE - Sketch 11

Because the divisor has been subtracted one extra time from the accumulator to cause an overdraft the machine must now go through a plus cycle to restore this amount to the accumulator.

When the accumulator is overdrafted the credit balance indicator extension is rocked counterclockwise, as shown in Sketch 11, rocking the negative zero block and the division overstroke bellcrank counterclockwise. This swings the division add-subtract interponent out of engagement with stud A on the automatic add-subtract lever. At the start of the next main clutch cycle when the division add-subtract follower drops to the low of the cam, the division add-subtract interponent cannot engage stud A to rock the shaft and the add-subtract symbol block into a minus position. Stud S on the division latch cam follower holds the automatic add-subtract lever in a plus position. During the minus cycle the division add-subtract interponent is rocked back to engage ear N of the division backspace bellcrank. When the division add-subtract follower drops to the low of the cam, in plus, the division add-subtract interponent rocks the division backspace bellcrank counterclockwise. This pulls the double plus blocking pawl down, stud W on the frame cams lip E into engagement with the first step of the double plus blocking lever and rocks it clockwise. Clockwise movement of the double plus blocking lever pushes the hook of the double plus blocking latch over ear P to hold the double plus blocking lever in the rocked position. On the first minus cycle following a plus cycle ear Y of the automatic add-subtract lever knocks the double plus blocking latch off ear P, allowing the double plus blocking lever to return to its home position. As the division backspace bellcrank is rocked clockwise, it pulls the division backspace link rearward, rocking the backspace control lever into position to backspace the carriages one order.

Add cycles are not counted in the memory unit, therefore when the add-subtract symbol block is in a plus position, as shown in Sketch 11, the add-subtract link holds the ear on the division bias trip leg over the end of the bias trip follower. At the beginning of the cycle the division bias cam rocks the bias trip follower up against the ear of the division bias trip leg pushing it upward. The upward movement of the division bias trip leg rocks the bias bail latch and the bias pawl away from the ear on the division bias bail. When

the ear is released the division bias bail and the counting finger (Sketch 10) are rocked out of engagement with the memory sectors by the spring.

If the plus cycle puts the accumulator in a positive condition again, the credit balance indicator extension will be rocked clockwise and move the division add-subtract interponent into engagement with stud A of the automatic add-subtract lever to set the controls for a minus operation on the next machine cycle. The selection carriage and the counting finger have been moved one order to the right by the backspace. The machine will now begin subtracting the divisor from the amount remaining in the accumulator. The minus cycles will continue until the accumulator is again overdrafted. At this time, another plus cycle will occur to restore the overdraft. These minus cycles alternating with a plus and backspace operation will continue until the amount in the accumulator is reduced to zero or the carriage is backspaced to its home position.

SECOND (ATTEMPTED) PLUS - Sketch 12

If the amount in the accumulator is evenly divisible by the divisor, the amount in the accumulator will be reduced to zero. At this point, the next minus operation will cause an overdraft in the accumulator and the credit balance indicator extension will set the controls for a plus operation. A plus operation to restore the overdraft and backspace operation will occur, Sketch 11, however, since the amount in the accumulator was zero before the last minus cycle took place, the plus operation will leave the accumulator with a negative zero. The credit balance indicator will not be moved, and the machine will remain conditioned for a second plus operation.

As explained in the previous section, during the first plus operation the double plus blocking lever is rocked clockwise and the double plus blocking latch hooked on the ear of the division latch cam follower. If a minus operation follows the plus operation the hook is released and the double plus blocking lever rocks back to its home position. However, if a second plus operation follows the first the division add-subtract interponent (Sketch 12) rocks the division backspace bellcrank, pulling the double plus blocking pawl down again. Since the double plus blocking lever is held clockwise by the double plus blocking latch the downward movement of the double plus blocking pawl causes stud W to cam ear E in to engage the second step on the double plus blocking lever and rock it farther clockwise. This additional clockwise rotation of the double plus blocking lever causes ear J to lift the division termination latch

away from ear H of the division latch cam follower and allows it to rock clockwise under spring tension. As the division latch cam follower rocks, the division restore clutch control is rocked out of engagement with the division program shaft clutch. Because the ratchet is positioned as shown in Sketch 12, the ratchet tooth will not pick up the clutch pawl until the beginning of the next machine cycle.

The clockwise movement of the division latch cam follower rocks the division latch live-point into a position to latch ear Z and prevent further operation of the division add-subtract follower. When the double plus blocking lever is rocked to its extreme clockwise position at the beginning of the second plus operation, the ear on the lower end is rocked under stud T of the left pendant drive power lever, blocking its downward movement. This prevents the engagement of the rear pendant with the accumulator so the second add operation does not change the amount in the accumulator.

Because the division backspace bellcrank is rocked clockwise and the division backspace link is pulled rearward, the backspace control lever will be conditioned for another backspace operation. This second backspace operation is not necessary but occurs only because of the nature of the mechanism.

As the division restore clutch control is rocked clockwise by the second plus operation stud M on the division bias blockout is rocked up to release the high speed microswitch, the remaining two machine cycles are done at the lower motor speed.

PRINT QUOTIENT - Sketch 13

During the second plus operation the pawl in the division program shaft clutch was released to engage the ratchet, but because this shaft turns at one-quarter the speed of the main drive shaft, the ratchet tooth does not contact the clutch pawl until the next machine cycle.

As the division program shaft begins to turn, the quotient bellcrank is rocked counterclockwise, causing stud A to rock the pendant block control arm. This arm, in turn, rocks the multiplier restore control bellcrank causing stud N to lift the restore push link into a position to intercept the stud on the actuator rocker gear sector.

The lifter bail latch blocking cam is rotated so it no longer blocks the stud on the left lifter bail latch. As the quotient bellcrank is rocked, stud R rocks the left lifter bail latch away from the ear

of the left lifter bail cam follower. The high speed print block cam rocks the high speed print control cam follower clockwise. This allows the print control arm to rock up far enough to release the ear of the left ribbon control arm to permit the machine to print. However, the print control arm and shaft are not rocked far enough for the square stud on the symbol block drive link to block the printing of the division symbol.

The machine is now conditioned for a "From Memory" operation. Since no controls have been set, the machine will automatically go through a "Non Add" cycle, printing the quotient stored in the memory unit.

CLEARING REMAINDER - Sketch 14

The division program cam rocks the division slide control cam follower counterclockwise. The lower end of the cam follower rocks the remainder arm clockwise to set the controls for a "Total" operation to clear out any remainder in the accumulator.

Near the end of the third quadrant of the division program shaft, or quotient printing cycle, the division slide control cam follower is rocked part way to the rear, pulling the rear division slide to the rear. This also pulls the division slide rearward. The division slide pivot arm is rocked counterclockwise and latched in place by roller R on the division slide latch. As the division slide pivot assembly is rocked clockwise, its lower arm allows the repeat link to rock up. This in turn rocks up the single cycle disabling link allowing the main clutch to return to single cycle operation, however, this happens too late to shut off the machine on this cycle. As ear D of the repeat link is rocked up, the repeat control lever is allowed to return to its home position, which in turn, allows the repeat bails (See Sketch 1) to rock out of engagement with the sector latches so the sectors can be restored. The carriage return control bail is rocked away from the ear of the carriage return control arm so the carriage can be restored.

During the early part of the fourth quadrant of the division program shaft, or remainder clearing cycle, the division slides (Sketch 14) are pulled farther to the rear. The hook on the division slide engages the stud on the division key control latch and rocks it clockwise. The tail of the division key control latch rocks the ear on the repeat control lever counterclockwise, to insure that this lever and all the parts which it controls are fully restored to their home positions. It also insures that the division slide is relatched even though the division key is held down. The carriage

return clutch (Sketch 3) is also disengaged by the restore of the division slide. The total and sub-total control lever is set in a total condition as the remainder arm is cammed clockwise by the division slide control cam follower. As the division program shaft continues through the fourth quadrant, the division high speed print block cam allows the high speed print control cam follower to rock rearward again to block the print of the remainder during the total operation. The carriage is cleared and restored to its home position because the backspace control lever is no longer blocking the carriage return control arm. As the selection carriage is restored to the right, the backspace rack is driven rearward by the gear train shown in Sketch 5. Rearward movement of the backspace rack (Sketch 14) rotates the carriage return clutch gear clockwise. The multiplier carriage restore arm is connected to the carriage return clutch gear by a torsion spring and rotates with it. As the multiplier carriage reaches home position the carriage stop latch latches the keyboard release arm to hold the carriage in place.

High point E (see Sketch 13) of the high speed print control cam restores the high speed print control cam follower, allowing the print control arm to rock up to its home position. The symbol block drive link which is pinned to the same shaft as the print control arm is also rocked up into position to block the symbol.

When the clutch dog latch is restored by the single cycle operation, the clutch throwout slides are pushed toward the front of the machine, releasing the division key.

TERMINATION BY CARRIAGE RESTORE - Sketch 15

If the dividend, amount in the accumulator, is not evenly divisible by the divisor in the selection unit, the machine will continue minus cycles, plus cycle and backspace operations until the carriage

has been returned to its extreme right position where the carriage overstroke initiates the termination.

The carriage overthrow cam is fastened to the carriage return clutch shaft. As the selection carriage is backspaced, the carriage return clutch shaft is rotated by the gear train (Sketch 5) to backspace the multiplier carriage. As the selection carriage reaches its extreme right order, the carriage overthrow cam (Sketch 15) on the carriage return clutch shaft has been rotated to a point where it contacts the stud on the division termination trip lever. The overstroke of the carriage overthrow cam rocks the division termination trip lever counterclockwise against the ear of the division termination latch, rocking it out of engagement with ear C of the division latch cam follower. When the division latch cam follower is released, it rocks clockwise under spring tension, and rocks the division clutch restore control out of engagement with the division program shaft clutch, allowing the machine to continue with the printing and restoring operations previously described from "Second (Attempted) Plus" on.

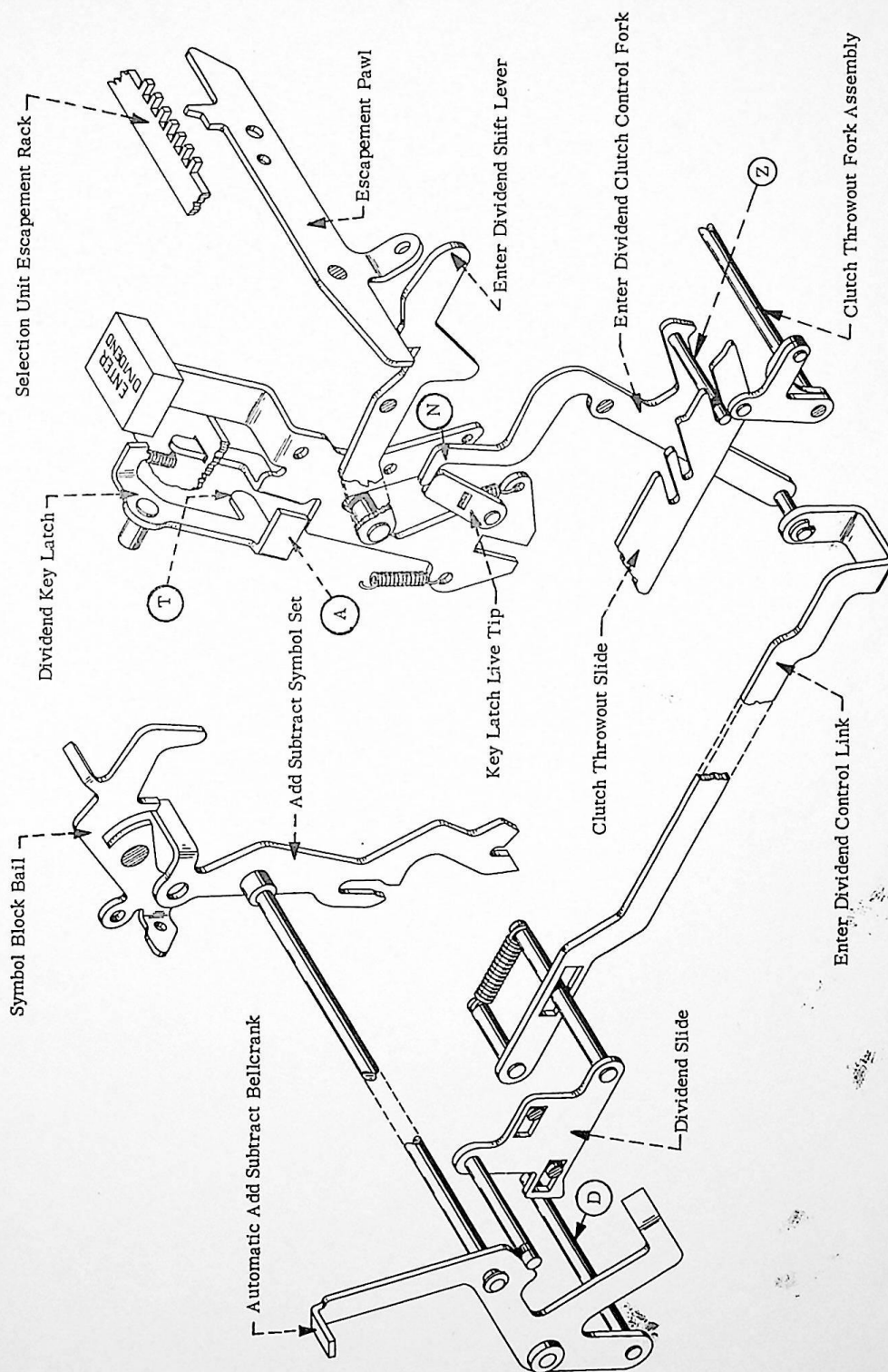
DIVISION STOP KEY - Sketch 16

The division stop key may be used to terminate the division operation in any order.

Depression of the division stop key will cause stud N to rock the division stop key bellcrank clockwise, pulling the division stop bellcrank clockwise. Clockwise movement of the division stop bellcrank causes lip R to contact the ear on the division termination latch rocking it clockwise and out of engagement with the ear H on the division latch cam follower. The division latch cam follower is rocked clockwise under spring tension, rocking the division clutch restore control, which is fastened to it, out of engagement with the division program shaft clutch, allowing the machine to continue into the print out and restore cycles.

FRIDEN PRINTING CALCULATOR

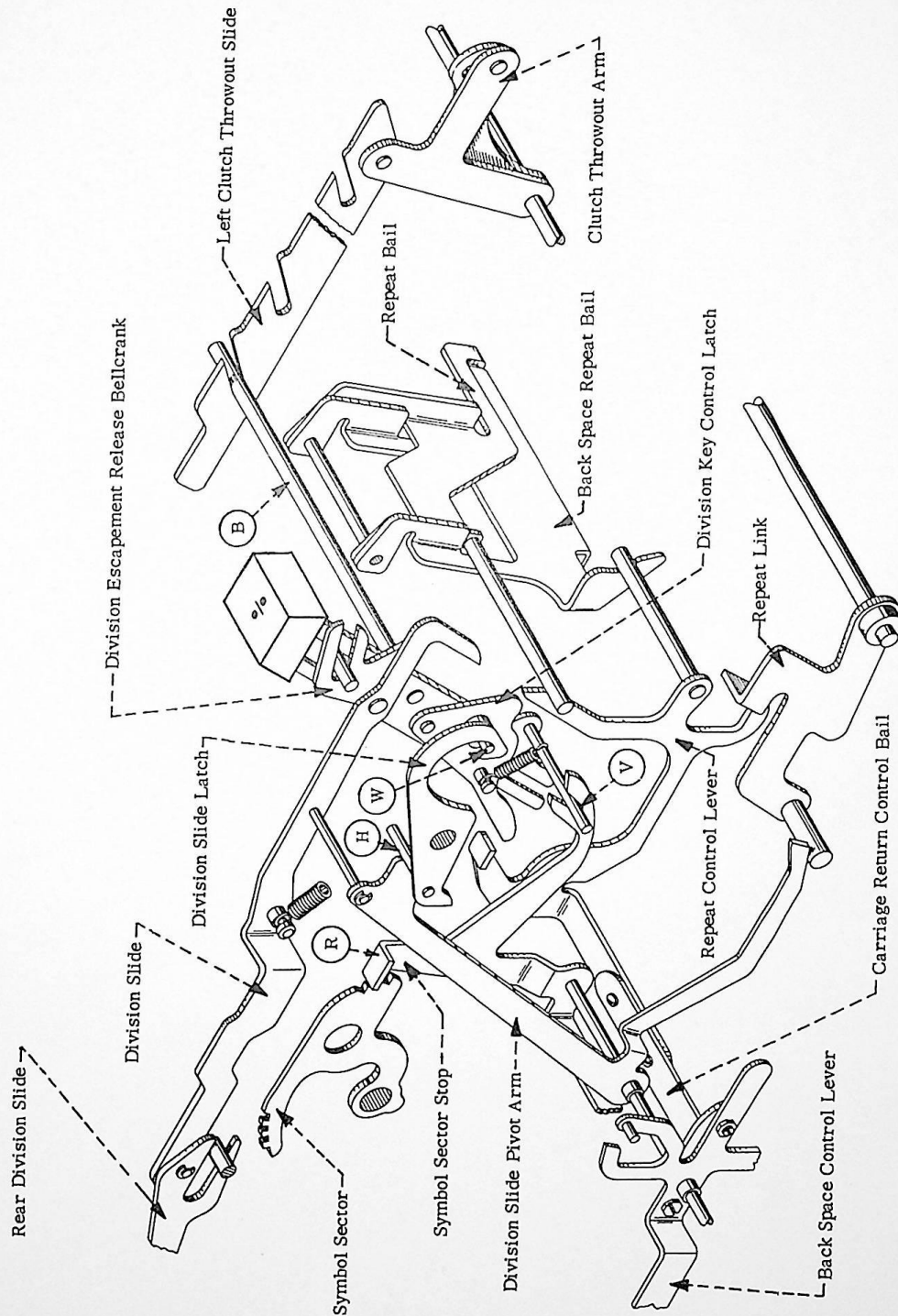
OPERATIONS - Division



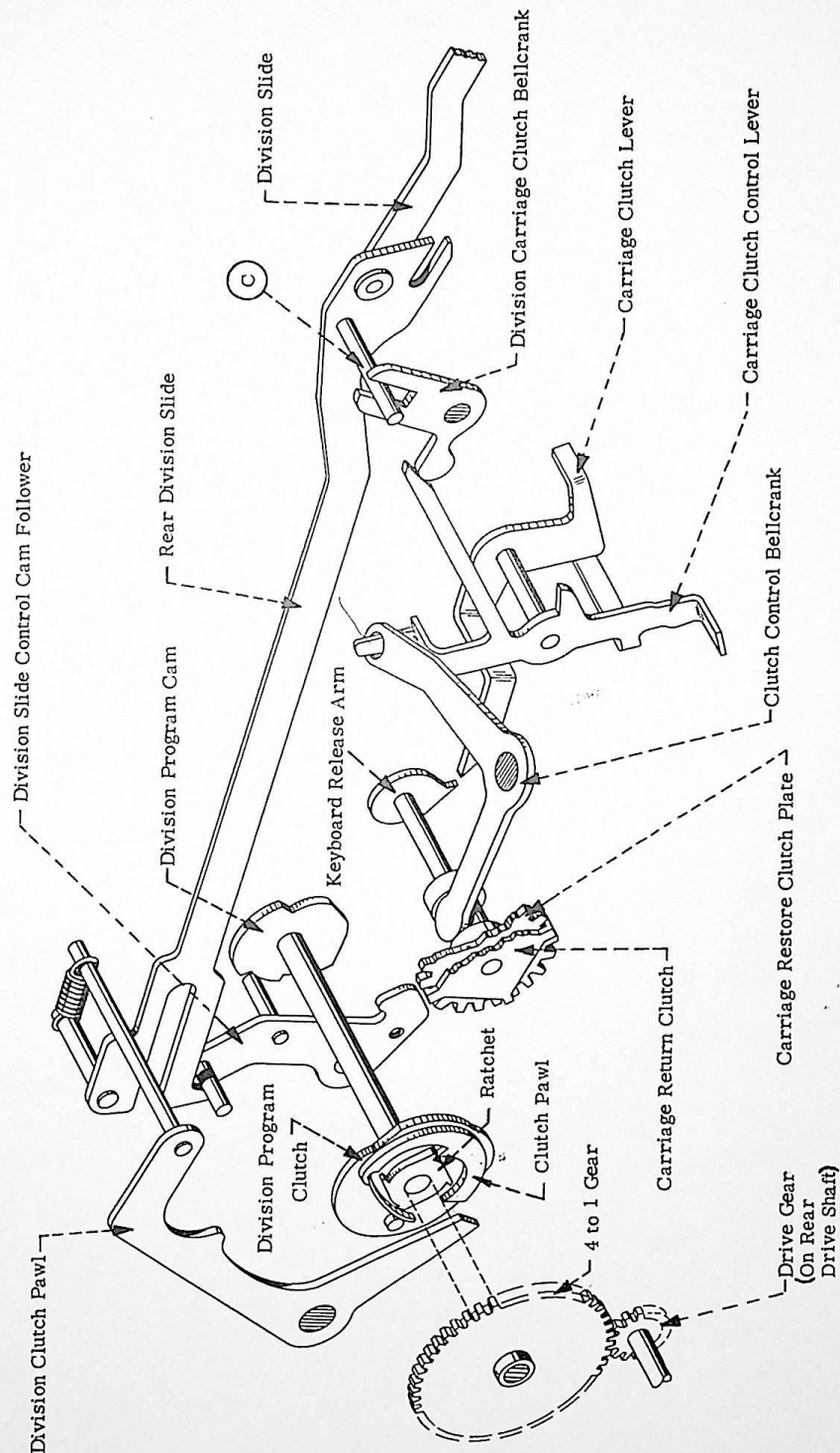
DIVISION
SKETCH 1

FRIDEN PRINTING CALCULATOR

OPERATIONS - Division

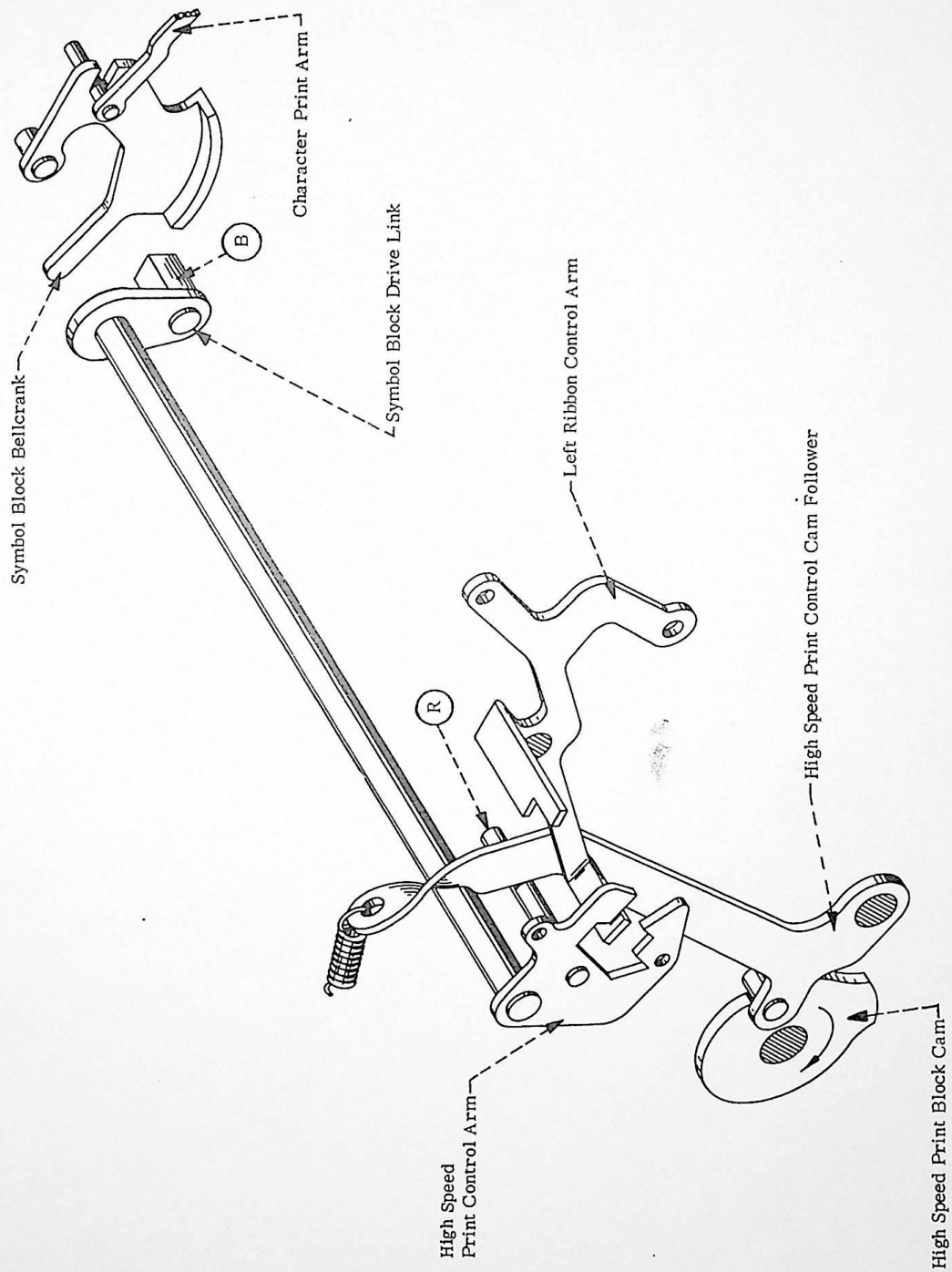


DIVISION
SKETCH 2

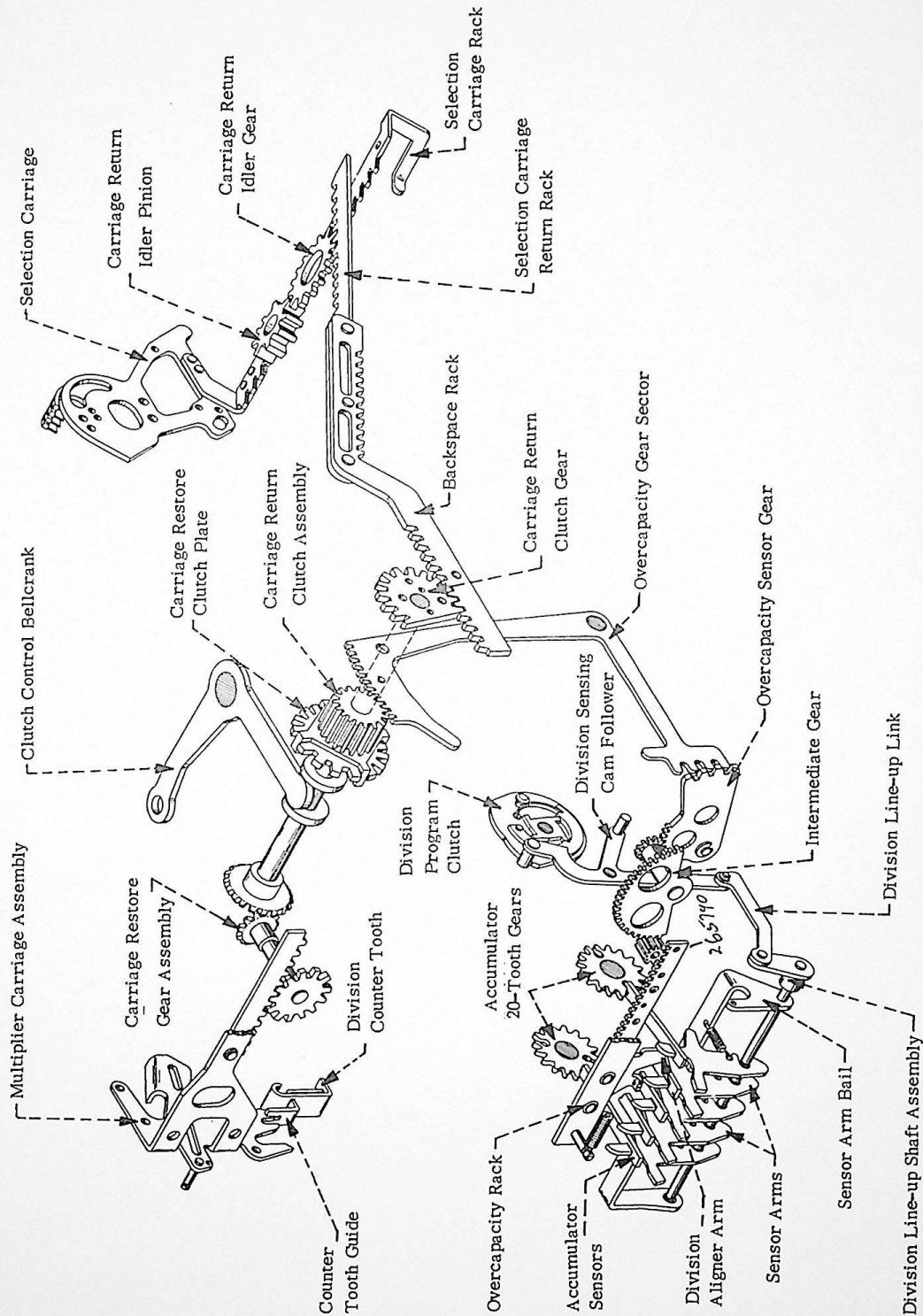


DIVISION
SKETCH 3

FRIDEN PRINTING CALCULATOR
OPERATIONS - Division

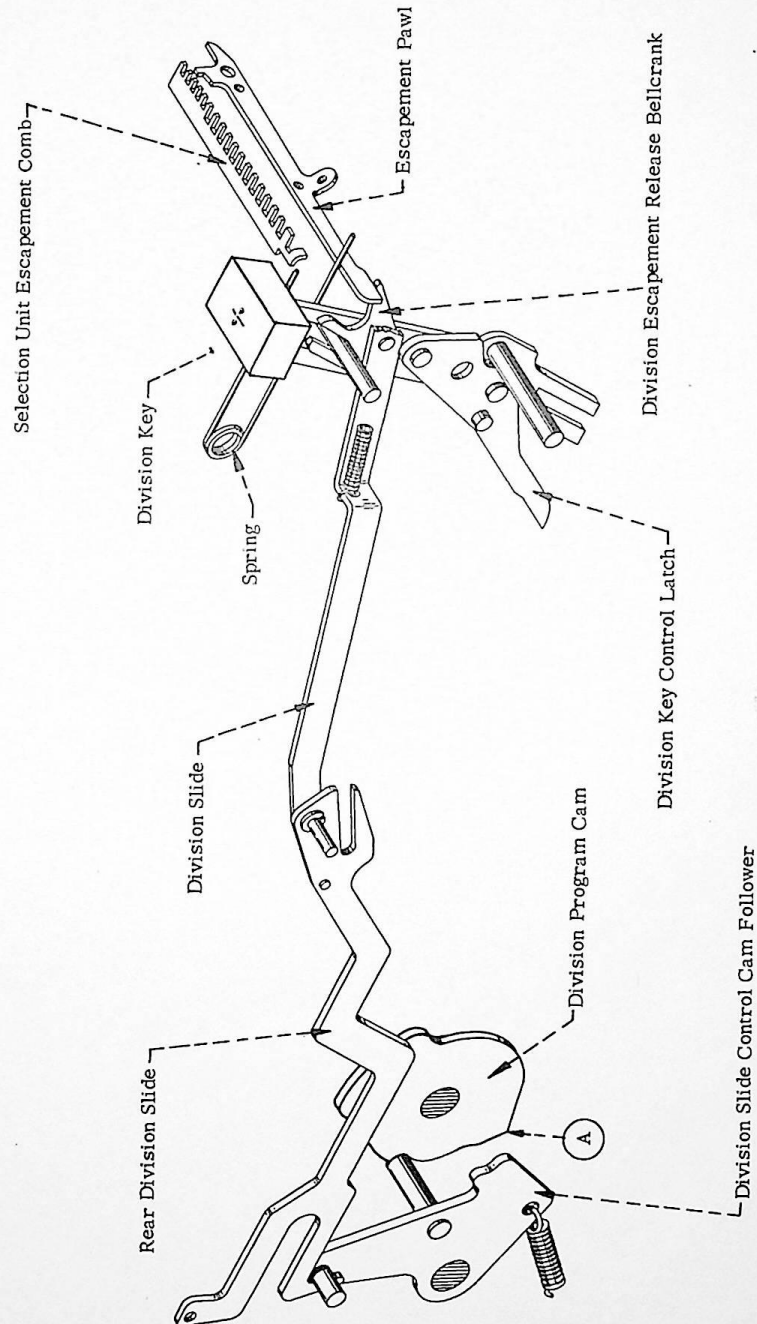


DIVISION
SKETCH 4

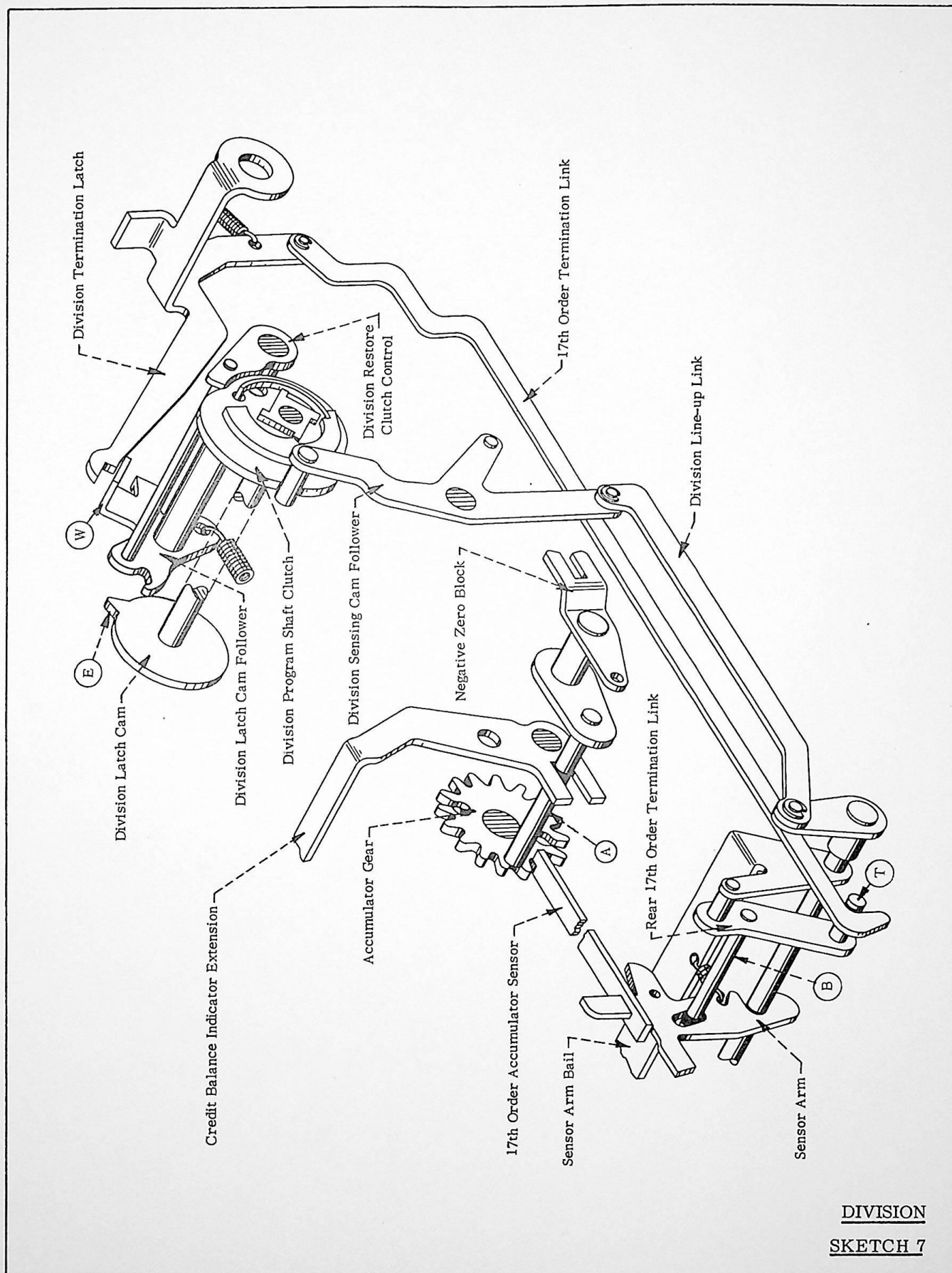


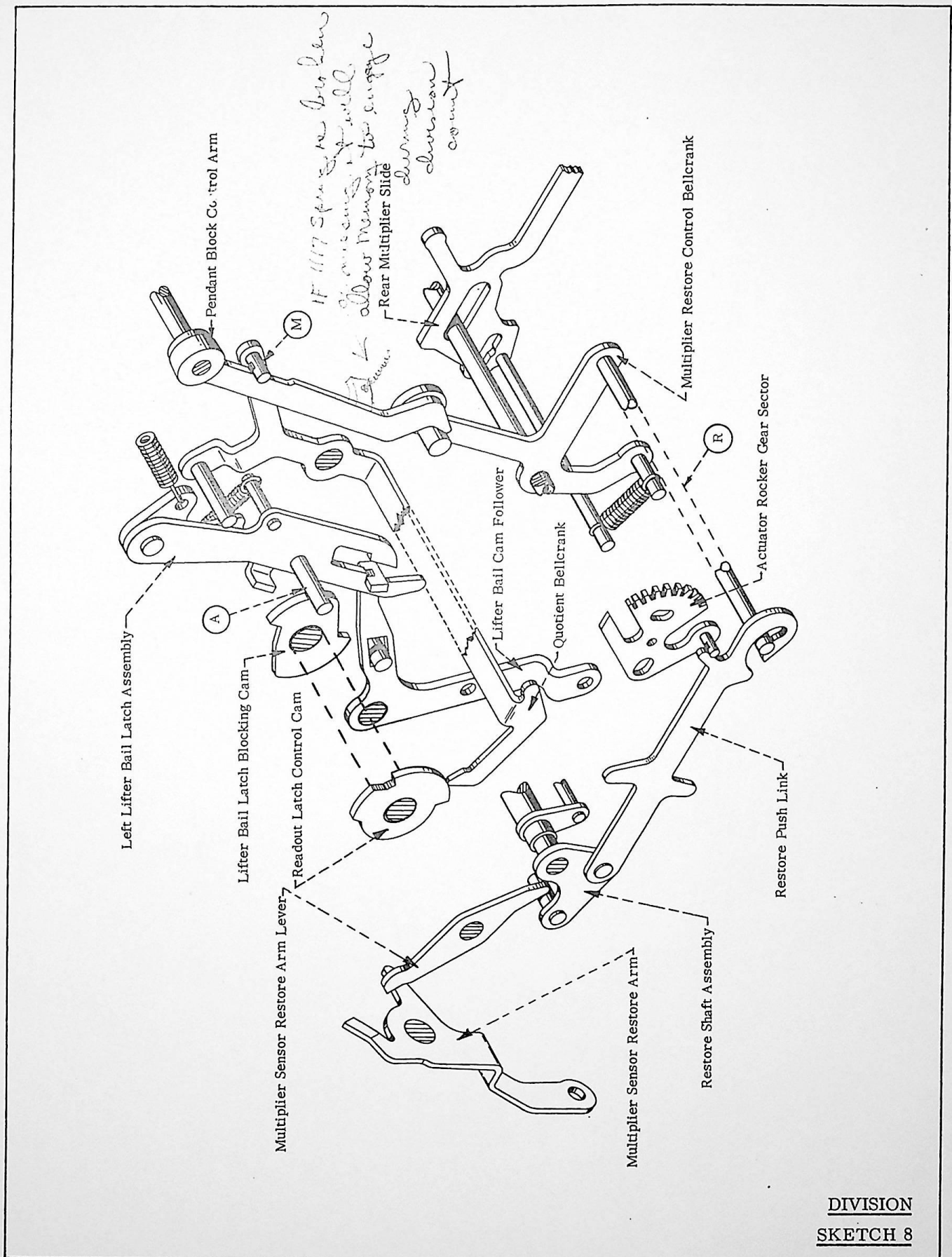
DIVISION
SKETCH 5

FRIDEN PRINTING CALCULATOR
OPERATIONS - Division

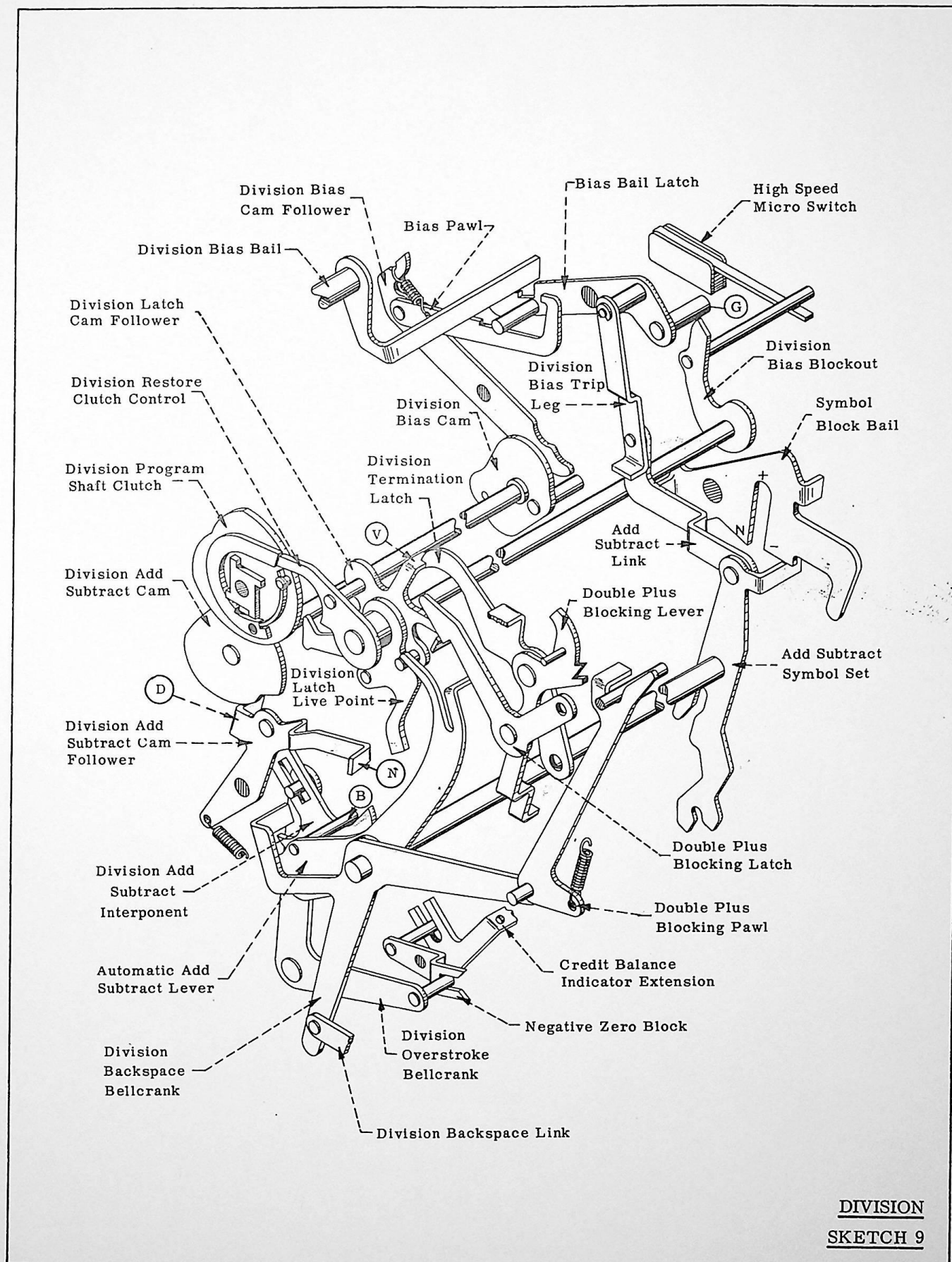


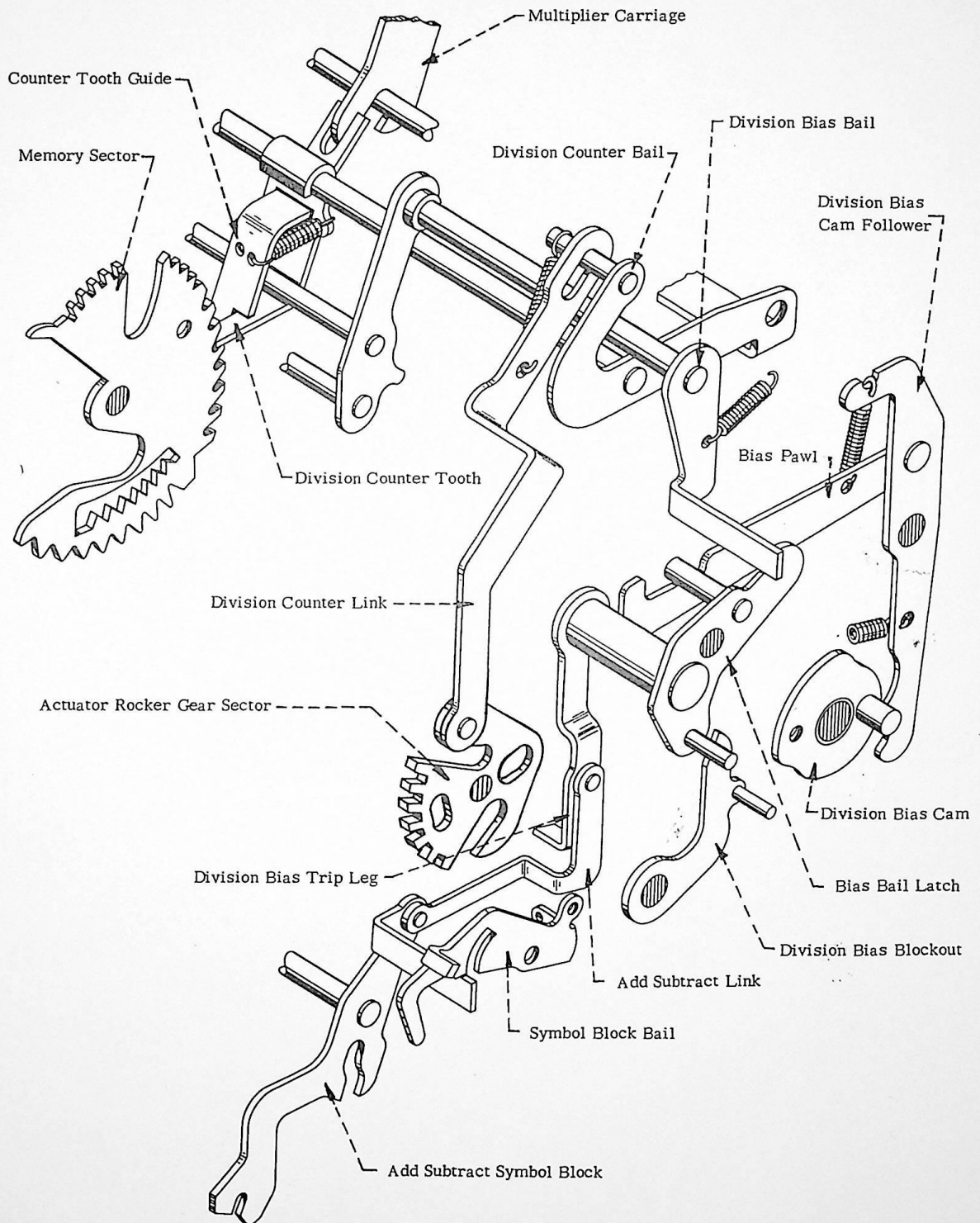
DIVISION
SKETCH 6

FRIDEN PRINTING CALCULATOR
OPERATIONS - Division



DIVISION
SKETCH 8

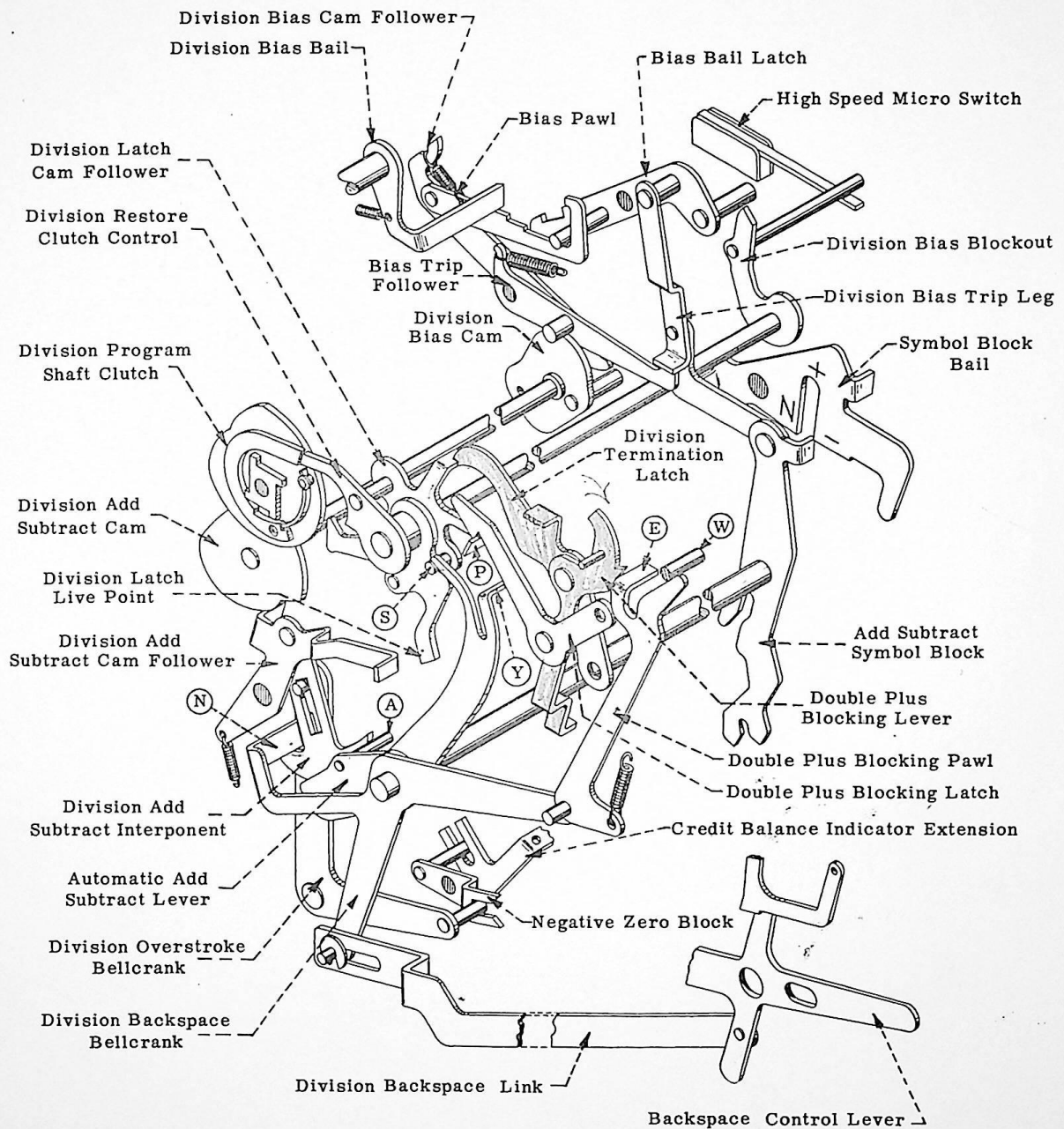


FRIDEN PRINTING CALCULATOR
OPERATIONS - Division

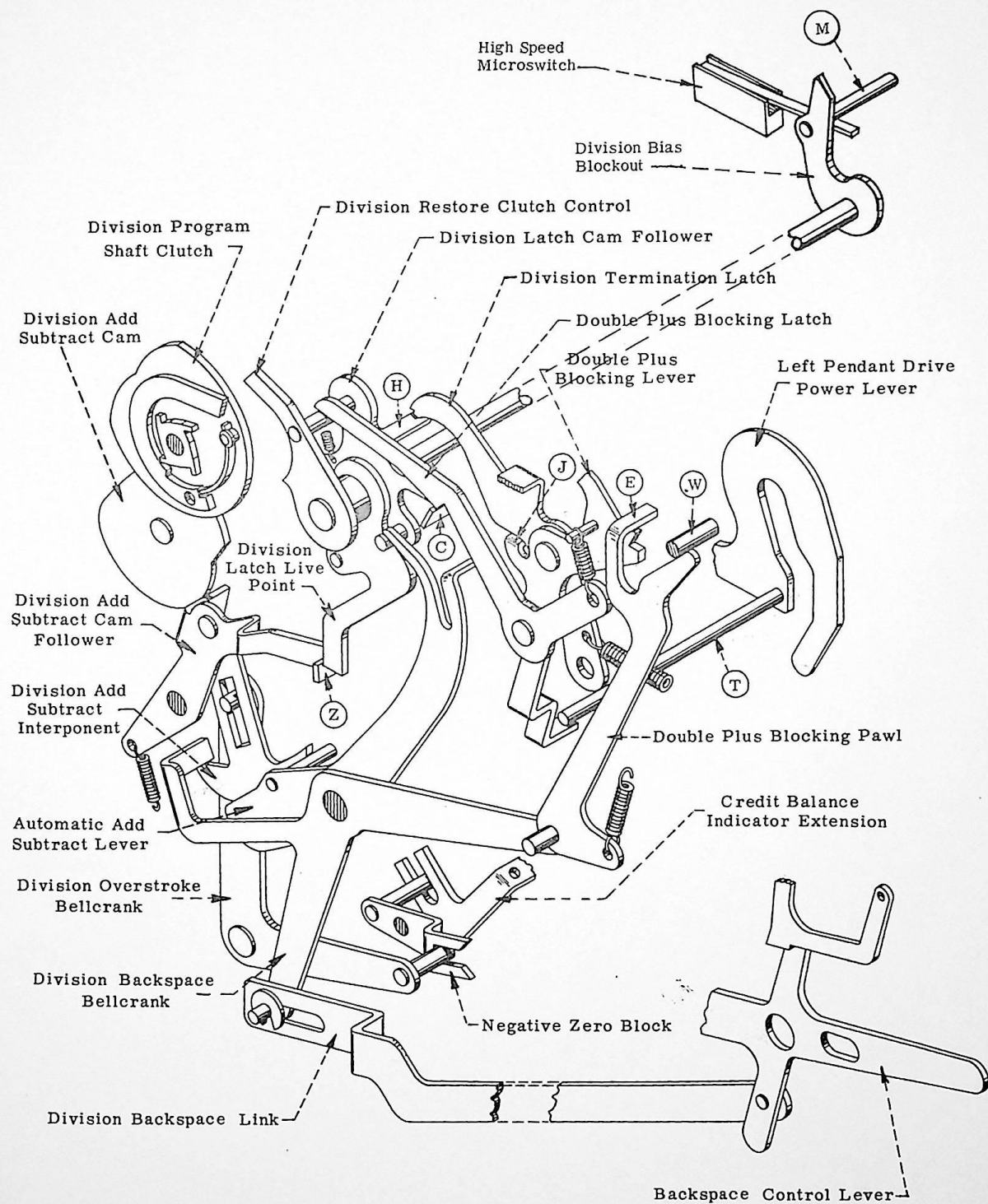
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SKETCH 10

FRIDEN PRINTING CALCULATOR

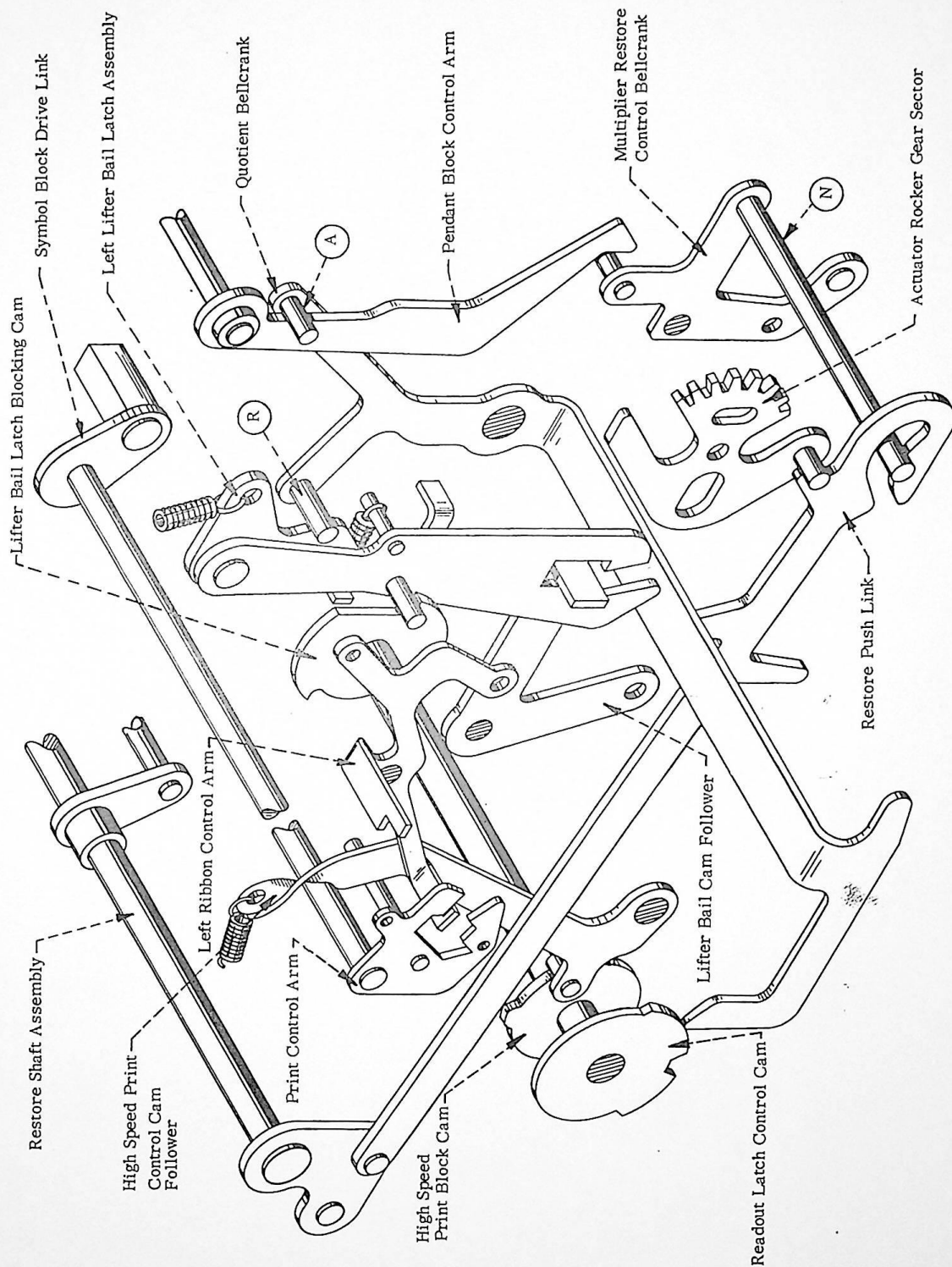
OPERATIONS - Division



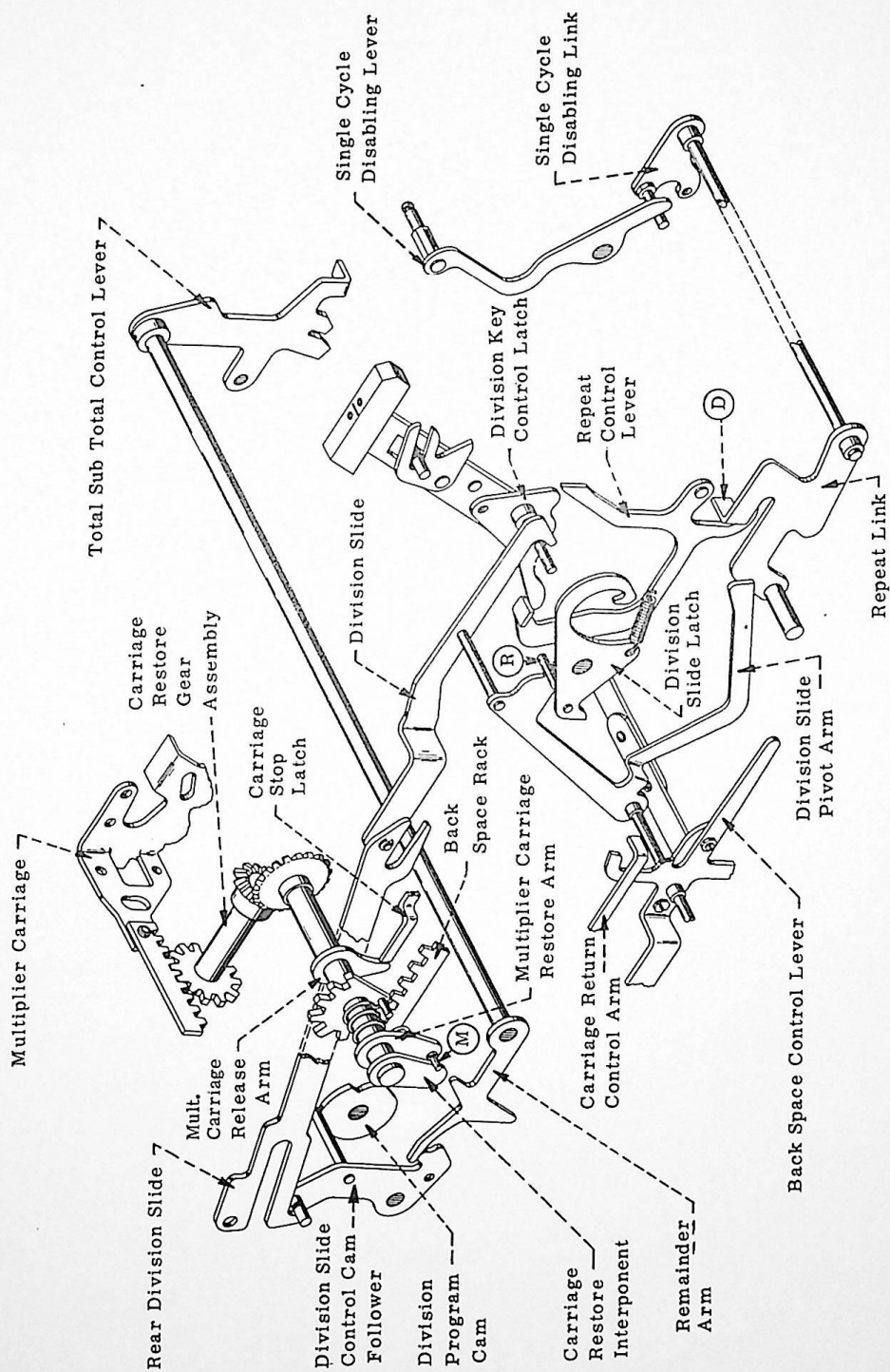
DIVISION
SKETCH 11



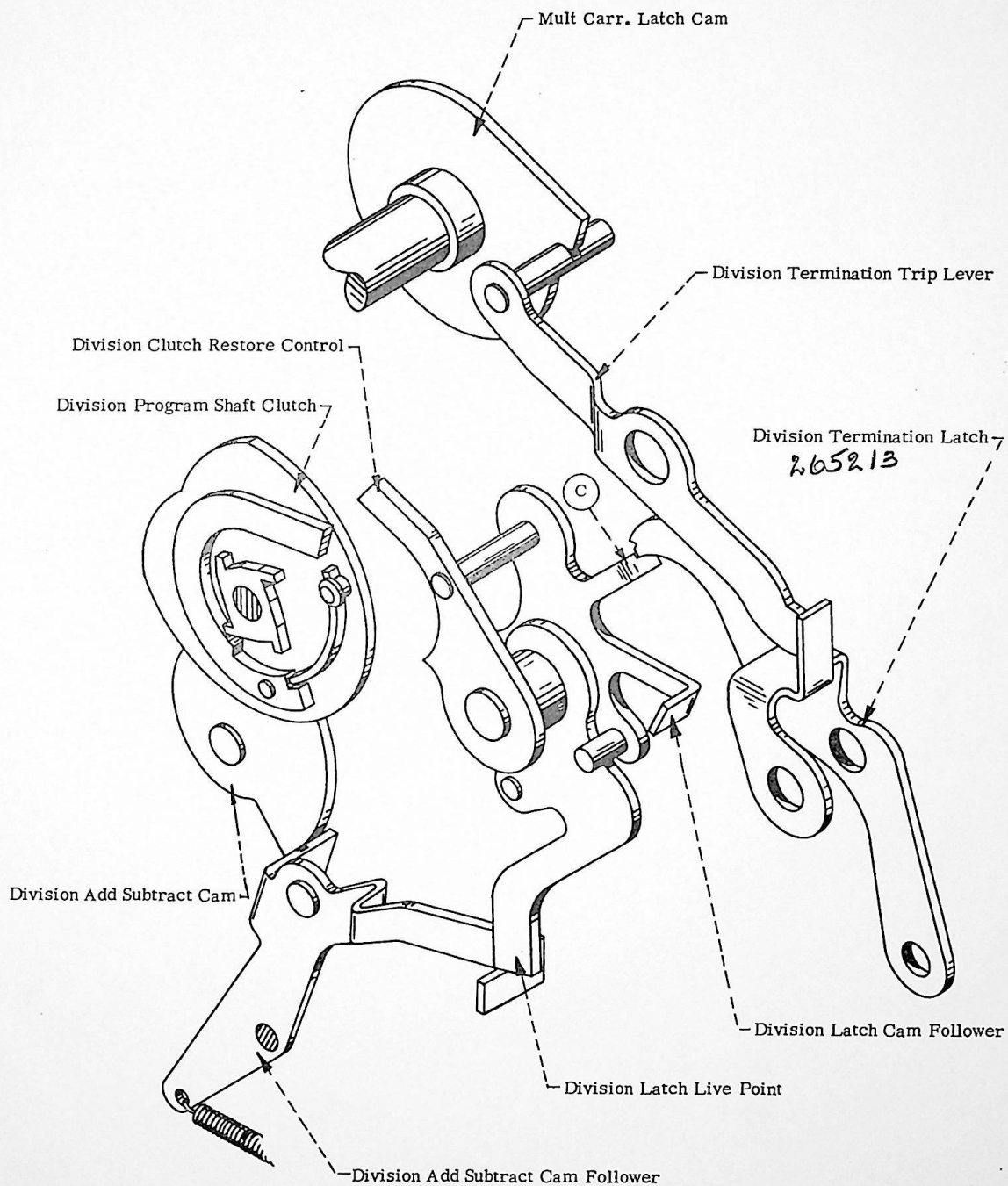
DIVISION
SKETCH 12



DIVISION
SKETCH 13



DIVISION
SKETCH 14



DIVISION
SKETCH 15